DRAFT

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT SITE
700 AREA
OPERABLE UNIT 8

U.S. DEPARTMENT OF ENERGY
ENVIRONMENTAL RESTORATION PROGRAM
ROCKY FLATS PLANT
GOLDEN, COLORADO

VOLUME I OF II

MAY 1, 1992

EG&G ROCKY FLATS

INTEROFFICE CORRESPONDENCE

DATE: March 6, 1992

TO: P. L. Fuller, Remediation Programs Division, Bldg. T130B, X5744

FROM: R. B. Hoffman, Classification Office, T893B, X4598 SLC for RBH

SUBJECT: CLASSIFICATION EXEMPTION WAIVER FOR REMEDIATION PROGRAMS DIVISION (RPD) DOCUMENTS

Your request for exemption from classification/UCNI review of Remediation Programs Division (RPD) documents as proposed in your letter of March 5, 1992 has been considered.

Based upon a substantial historical perspective, we have concluded that the reporting activities in which your Division of the Environmental Management Department is involved are unclassified and UCNI-free in nature and content.

All reporting activities for those Operable Units (OUs) one thru sixteen, except, Operable Unit 15 - Inside Building Closures, can be considered as exempt from further classification/UCNI review by the Classification Office. This waiver includes internal, as well as, external letters, work plans, reports, interim measures, RCRA facilities investigations, interim remedial actions, site characterization studies, human health risk assessments, environmental evaluations and assessments, comparative analyses, and other environmental and administrative documentation, as outlined in your letter. At this time sufficient knowledge of the type of information which OU 15 will comprise has not been established and until this can be acertained, classification review will be necessary.

In general, should RPD documents begin to differ in scope and context from past practice, it will become mandatory that you contact this office to ensure that this classification review waiver be justified and correct.

Should you require any further information or have any questions regarding this matter, please feel free to contact me or Karl Dallarosa (X3792) at any time.

kld

cc:
P. S. Bunge
J. E. Evered
W. A. Hunt

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ROCKY FLATS PLANT

700 AREA

OPERABLE UNIT NO. 8

U.S. DEPARTMENT OF ENERGY

Rocky Flats Plant

Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

May 1992

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1.0 INTRODUCTION

This document presents the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 8 (OU8) at the U.S. Department of Energy (DOE) Rocky Flats Plant (RFP) in Jefferson County, Colorado.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at RFP. These investigations are pursuant to an Interagency Agreement (IAG) between DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated January 22, 1991 (DOE, 1991a). The IAG addresses RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) issues. Although the IAG requires general compliance with both RCRA and CERCLA, CERCLA regulations apply to remedial investigations at OU8. In accordance with the IAG, the CERCLA terms "remedial investigation" and "feasibility study" as used in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study" (CMS), respectively. Also in accordance with the IAG, the term "Individual Hazardous Substance Site" (IHSS) is equivalent to the term "Solid Waste Management Unit" (SWMU).

1.1 WORK PLAN SCOPE

As required by the IAG, this Phase I Work Plan addresses characterization of sources of contamination and environmental media at each IHSS in OU8. It will also address the nature and extent of contamination at each IHSS, migration pathways, and receptor exposure.

In this Work Plan, the existing information is summarized to characterize OU8, data gaps or other requirements are identified, data quality objectives (DQOs) are established, and a Field Sampling and Analysis Plan (FSAP) is presented to characterize site physical features, define

contaminant sources, and assess the extent of contamination. Also included are plans to conduct a human health risk assessment plan (Section 8).

The Phase I RFI/RI will be conducted in accordance with the Interim Final RCRA Facility Investigation (RFI) Guidance (EPA, 1989a) and Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988). Unless otherwise explained and rationale provided, the minimum investigative action required by the IAG, Attachment 2, Section VI, and Table 5 (See Appendix A) will be performed at each IHSS within OU8. Existing data and data generated by the Phase I RFI/RI will be used to begin developing and screening remedial alternatives and to estimate the risks to human health and the environment posed by sources within OU8.

1.2 ENVIRONMENTAL RESTORATION PROGRAM AT RFP

The Environmental Restoration (ER) Program, designed for investigation and cleanup of environmentally contaminated sites at DOE facilities, is being implemented in five phases. Phase 1 (Installation Assessment) includes preliminary assessments and site inspections to assess potential environmental concerns. Phase 2 (Remedial Investigations) includes planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites and evaluate potential contaminant migration pathways. Phase 3 (Feasibility Studies) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified during remedial investigations as needing corrective actions. Phase 4 (Remedial Design/ Remedial Action) includes design and implementation of site-specific remedial actions selected on the basis of feasibility studies. Phase 5 (Compliance and Verification) includes monitoring and performance assessments of remedial actions as well as verification and documentation of the adequacy of remedial actions carried out under Phase 4.

Initial Phase 1 actions have been completed at RFP (U.S. DOE, 1986); in addition, Phase 2 actions are currently in progress for OU8. This Work Plan is intended to complete the additional

Phase 1 activities to further locate and assess potential and known release sites and provide supplemental sampling and analytical data to evaluate the extent and magnitude of contamination onsite and offsite of individual IHSSs and OU8.

1.3 OVERVIEW OF WORK PLAN

This Work Plan presents an evaluation and summary of previous data and investigations, defines data quality objectives (DQOs) and data needs based on that evaluation, specifies Phase I RFI/RI tasks, and presents the Field Sampling and Analysis Plan (FSAP) activities and procedures to be implemented during the OU8 Phase I RFI/RI.

This Work Plan is organized as follows:

- Section 1.0 provides introductory information and a general characterization of RFP. This includes a description of the Work Plan Scope, Environmental Restoration Program at RFP, an Overview of the Work Plan, Regional and Plant Site Background Information, and Previous Investigations. Included in this are discussions of the Physical Setting for topography and drainage, geology and soils, and hydrogeology.

- Section 2.0 presents a comprehensive review and analysis of the available historical information, previous environmental investigations, recently published reports, available data, past and present activities pertinent to OU8, and interrelation of OU8 activities with those of other OUs.

  The Initial Evaluation of IHSSs within OU8, includes conceptual models for contaminant migration and exposure pathways based on release mechanisms, site physical characteristics, and available information regarding the nature of contaminants and knowledge of Potential Areas of Concern (PACs). PACs are similarly evaluated and related to evaluation of contamination occurring at IHSSs within the immediate proximity. This initial characterization provides the basis for establishing data needs, DQOs, and for developing protocols, procedures and rationale for activities to be conducted during implementation of the FSAP.

- Section 3.0 presents potential sitewide Applicable or Relevant and Appropriate Requirements (ARARs), as required by the IAG, and a discussion of their application to the RFI/RI activities at OU8.

- Section 4.0 discusses the Sampling Rationale and the DQOs for the Phase I RFI/RI.

- Section 5.0 provides a discussion of the tasks planned in this Phase I RFI/RI Work Plan Tasks and includes a preliminary schedule for performance of those activities, including conformance with the IAG Schedule.

- Section 6.0 outlines the Preliminary Remedial Action Alternatives, including those for surface water and sediments, surficial materials and soils, groundwater, and air.

- Section 7.0 presents the FSAP for the Phase I RFI/RI to satisfy the data needs pursuant to section 5.0 and DQOs outlined in Section 10.0. This includes the Field Sampling Rationale; Phase I RFI/RI Objective; Integration with RFP Standard Operating Procedures; Sampling Design, Location, and Frequency; Sample Collection and Analysis; and QA/QC Procedures and Addendum.

- Section 8.0 provides the Human Health Risk Assessment Plan. This includes the baseline risk assessment approach (BRA), Data Evaluation and Identification of Chemicals of Potential Concern, Toxicity Assessment, Exposure Assessment, Risk Characterization, Uncertainty Analysis, Derivation of Chemical Goals, Risks from Radionuclides, and Risk Assessment Report.

- Section 9.0 discusses the plans to perform an Ecological Evaluation at OU8.

- Section 10.0 provides a the Quality Assurance/Quality Control Procedures and Addendum as supplied by EG&g for OU8.

- Section 11.0 lists references cited throughout this Work Plan.

- Appendix A provides Tables 5 and 6 from the IAG which outline the recommended scope of investigative activities for each OU8 IHSS and the schedule for completion of RI/RFI milestones.

- Appendix B presents additional information on the history of operations and current conditions of each IHSS that was obtained during the preparation of this Work Plan.

- Appendix C contains the a tabular summary of wells and boreholes surrounding OU8.

- Appendix D contains geologic logs and well-construction diagrams for wells and boreholes included in geologic cross sections presented in this Plan.

1.4 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

1.4.1 Facility Background

RFP is a government-owned, contractor-operated facility, which is part of the nationwide Nuclear Weapons Complex. The plant was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by DOE in 1977. Dow Chemical U.S.A., an OU of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating RFP from July 1, 1975 until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor at RFP on January 1, 1990.

1.4.2 Rocky Flats Plant Operations

Operations at RFP consist of fabrication of nuclear weapons components from plutonium, uranium, and other nonradioactive metals (principally beryllium and stainless steel). Parts made at the plant are shipped elsewhere for assembly. In addition, the plant reprocesses components after they are removed from obsolete weapons for recovery of plutonium. Other activities at RFP include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in the various production processes. Current waste handling practices involve onsite and offsite recycling of hazardous materials, offsite disposal of solid radioactive materials at another DOE facility, and onsite storage of hazardous and radioactive mixed wastes. However, RFP operating procedures historically included both onsite storage and disposal of hazardous, radioactive, and radioactive mixed wastes. Preliminary assessments under the ER Program have identified many of the past onsite accidental release sites and storage and disposal locations as potential sources of environmental contamination.

1.5 PREVIOUS INVESTIGATIONS

Various sitewide studies have been conducted at RFP to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations performed prior to 1986 were summarized by Rockwell International (1986a) and include the following:

1. Detailed description of the regional geology. (Malde, 1955; Spencer, 1961; Scott, 1960, 1963, 1970, 1972, and 1975; Van Horn, 1972 and 1976; Dames and Moore, 1981; and Robson, et al., 1981 and 1981a).

2. Several drilling programs beginning in 1960 that resulted in construction of approximately 60 monitoring wells by 1982.

3. An investigation of surface water and ground water flow systems by the U.S. Geological Survey USGS (Hurr, 1976).

4. Environmental, ecological, and public health studies that culminated in an Environmental Impact Statement (EIS) (DOE, 1980).

5. A summary report on groundwater hydrology using data from 1960 to 1985 (Hydro-Search, 1985).

6. A preliminary electromagnetic survey of the RFP perimeter (Hydro-Search, 1986).

7. A soil-gas survey of the RFP perimeter and buffer zone (Tracer, 1986).

8. Routine environmental monitoring programs addressing air, surface water, groundwater, and soils (Rockwell, 1975 through 1985, and 1986b).

In 1986, two major investigations were completed at RFP. The first was the DOE Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1 Installation Assessment (DOE, 1986), which included analyses and identification of current operational activities, active and inactive waste sites; current and past waste management practices; and potential environmental pathways through which contaminants could be transported. CEARP was succeeded by the Environmental Restoration Program. A number of sites that could potentially have adverse impacts on the environment were identified. These sites were designated as

SWMUs by Rockwell International (1987a). In accordance with the IAG, SWMUs are now designated as IHSSs, which were divided into three categories:

1. Hazardous substance sites that will continue to operate and require a RCRA operating permit;

2. Hazardous substance sites that will be closed under RCRA interim status; and

3. Inactive hazardous substance sites that will be investigated and cleaned up under CERCLA or Section 3004(u) of RCRA.

The second major investigation completed at RFP in 1986 involved a hydrogeologic and hydrochemical characterization of the plant site. Plans for this study were presented by Rockwell International (1986c and 1986d), and study results were reported by Rockwell International (1986d). Investigation results identified areas considered to be significant contributors to environmental contamination.

1.6 PHYSICAL SETTING

1.6.1 Location

RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, all of which are located less than 10 miles to the northwest, east, and southeast, respectively. The plant consists of approximately 6,550 acres of federal land in Sections 1 through 4, and 9 through 15 of Township 2 South, Range 70 West, 6th P.M. The majority of buildings located within the RFP site are concentrated on approximately 400 acres. RFP is surrounded by essentially an unoccupied buffer zone of approximately 6,150 acres (Figure 1-2).

RFP is bounded on the north by State Highway 128, on the east by Jefferson County Highway 17 (also known as Indiana Street), on the south by agricultural and industrial properties and State Highway 72, and on the west by State Highway 93.

OU8 is located on approximately 150.85 acres in the north-central industrialized area of the RFP. The boundary of OU8 is polygonal in shape and encompasses a majority of the Production (high-security) Area of the plant site. Figure 1-3 locates the 38 IHSSs for which Phase I RFI/RI activities are planned and discussed in this Work Plan.

Information presented in the following discussion of IHSSs (Sections 2.3 and 2.5) is taken from descriptions presented in the Historical Release Report (DOE, 1992) for the RFP, engineering designs drawings, and facilities drawings. For several IHSSs, this information was recently updated by Doty & Associates, Boulder, Colorado as part of a subtask to preparing this Work Plan (Appendix B). This research has been included in the IHSS descriptions provided below. This research includes additional background information regarding release mechanisms, revisions to IHSS size and location, and the nature of operations and potential contaminants occurring at a given site.

1.6.2 Surrounding Land Use and Population Density

The population, economics, and land use of areas surrounding RFP are described in a 1989 Rocky Flats vicinity demographics report prepared by DOE (DOE, 1991a). This report divides general use of areas within zero to five miles of RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications and outlines current and future land use near the plant.

The majority of residential use within 5 miles (8 km) of RFP is located northwest, west, southwest and south of the existing RFP. Figure 1-4 shows the 1990 population distribution within a 5-mile radius from the center of RFP. Commercial development is concentrated near the residential developments around Standley Lake, primarily north and southwest, and around the Jefferson County Airport (Jeffco), which is located approximately three miles (4.8 km) northeast of RFP. Active industrial land use within 5 miles (8 km) of the plant is limited to quarrying and mining operations located on lands directly west and southwest of RFP property.

There are several pockets of industrially zoned property located all around the property, both directly adjacent and nearby. This property is not likely to be developed any time in the near future due to a lack of water for fire protection. These properties must be accepted into a fire protection district in order to be developed for commercial or industrial use. To date, no Fire Protection District has been willing to accept the property, and it is anticipated that these properties will remain undeveloped in the near future. Open Space lands are located northeast of RFP near the City of Broomfield, and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and non-irrigated croplands, producing primarily wheat and barley, are located northeast of RFP near the cities of Broomfield, Lafayette, and Louisville, north of RFP near Louisville and Boulder, and in scattered parcels adjacent to the eastern boundary of the plant. Several horse operations and small hay fields are located south of RFP.

Future Population and Land Use Projections

Future land use in the vicinity of RFP most likely will involve continued suburban expansion, increasing the density of residential, commercial and industrial land use in the surrounding areas. The expected trend in population growth in the vicinity of RFP is addressed in the DOE demographics study (DOE, 1991a). This report considers expected variations in population density by comparing the current (1989) setting to population projections for the years 2000 and 2010. A 21-year profile of projected population growth in the vicinity of RFP can thus be examined. The DOE projections are based primarily upon long-term population projections developed by the Denver Regional Council of Governments (DRCOG). Expected population density and distribution around RFP for the years 2000 and 2010 are shown in Figures 1-5 and 1-6, respectively. Table 1-1 summarizes the population data presented in Figures 1-4, 1-5, and 1-6.

1.6.3 Topography

RFP is situated along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. RFP is at an average elevation of approximately 5,950 feet above mean sea level (MSL). The site is located on a broad, eastward-sloping alluvial surface. The surface of the alluvium is nearly flat but slopes gently eastward at 50 to 100 feet per mile (EG&G, 1991b). At RFP, the alluvial surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys containing Rock Creek, North and South Walnut Creeks, and Woman Creek are cut 50 to 200 feet below the level of the older alluvial surface in the vicinity of RFP.

1.6.4 Climate and Meteorology

Atmospheric transport of contaminants from RFP is controlled by climate, local meteorology, topography and land surfaces, on-site structures, and contaminant type and concentration. This information is necessary when evaluating the environmental and human health aspects attributable to atmospheric dispersion of OU8 IHSS site contaminants.

1.6.4.1 Climate

The climate at RFP is strongly influenced by the Front Range of the Rocky Mountains. Dry cool winters with some snow cover and warm moderately moist summers are typical. The temperatures at RFP averages a maximum of 24.4°C (76°F) and a minimum of -5.56°C (22°F); Annual mean temperature approximates 9.78°C (49.6°F). Recorded RFP temperature extremes range from 38.89°C (102°F) in July to -32.22°C (-2°F) in January (Schleicher and Schuell, 1982). Infrequent cloud cover over the region allows intense solar heating of the ground surface. The low absolute humidity permits rapid radiant cooling at night. Relative humidity averaged 46% for the period from 1954-1976 (Rockwell, 1989).

Colorado has inconsistent visual air quality conditions. The atmosphere over much of the Rocky Mountains is aesthetically satisfactory. However, the Denver "brown cloud" and visibility problems commonly associated with individual Front Range communities exemplify the consequences of low-level atmospheric stagnation that can occur with air pollutants emitted in Colorado (EG&G, 1990).

Regional topography and upper-level wind patterns combine to create a semiarid climate along the foothills of the Front Range of the Rocky Mountains. Average annual precipitation is approximately 15 inches with more than 80 percent of this falling as rain between April and September. The remaining precipitation is snow (Rockwell, 1989).

1.6.4.2 Meteorology

Meteorology is influenced by local topography, regional mountain ranges, and large-scale weather systems. The orientation of the Front Range of the Rocky Mountains greatly affects local winds. The RFP lies in a belt of prevailing northwesterly winds that are normally channeled across the eastern geological bench called Rocky Flats. High velocity winds have been recorded at the RFP under these meteorological conditions. High winds occur most frequently in the spring.

The RFP is affected by drainage winds from Front Range canyons. These channeled airflows are especially pronounced under conditions of strong atmospheric stability. Similarly, daily cycles of mountain and valley breezes occur at RFP. The general upslope air pattern condition for the Denver area is north to south with flows moving up the South Platte River Valley and entering Front Range canyons. After sunset the air that contacts mountain surfaces begins to cool and move downslope, thereby flowing in a pattern generally the inverse to upslope movements. Downslope flows converge with the South Platte River Valley flow and move toward the north-northeast.

Strong surface air convections commonly produce thunderstorms during the summer. This activity causes severe and locally unpredictable anomalies in normal air flows. Late winter and spring conditions can also be influenced by chinook windstorms. Chinooks consist of strong winds that move from west to east over the continental divide and often reach 70-80 mph. Chinooks have been recorded in excess of 120 mph at RFP (Rockwellb, 1989).

The mean wind speed at the RFP for 1990 was 9.0 mph. The highest reported wind speed was 88.6 mph. Figure 1.7 illustrates the annual RFP wind frequency distribution facing true bearing compass point directions. The predominance of northwesterly winds and the low frequency of winds greater than 15.6 mph (7 m/s) with easterly components is typical for RFP (EG&G, 1990).

Precipitation in the RFP area primarily occurs as snowfall or short-duration thunderstorms. These localized thunderstorms are generally one hour or less in duration, and their areal extent is usually limited to approximately one square mile (ASI, 1991a). The precipitation data are collected and recorded in the West Buffer Zone Meteorological Station (MetSta). Over the long term, the average annual precipitation at RFP has averaged nearly 15.2 inches (ASI, 1991b).

Although RFP-site-specific data are limited, annual evaporation at the RFP site is estimated to be between 31 and 38 inches. This is based upon long-term records at Cherry Creek Dam and Fort Collins, respectively (ASI, 1991b).

1.6.5 Ecology

A variety of plant life is found within RFP. The dominant vegetation found on the western portion of the site is disturbed mixed prairie, a mixture of both short and mid-length grasses. The eastern portion of RFP is generally highly disturbed through overgrazing, and short grasses are dominant. Sedges (*Carex nebraskensis*) and rushes (*Juncus arcticus*) are found in stream floodplains and wet valley-bottoms. Cottonwoods (*Populus sargentii*) and cattails (*Typha latifolia*) line many riparian areas.

Since acquisition of the buffer-zone property, vegetative recovery has occurred, as evidenced by the presence of disturbance-sensitive species such as big bluestem (*Andropogon gerardii*) and side oats grams (*Bouteloua curtipendula*). One vegetative species, Ute Ladies'-tresses (*Spiranthes diluvialis*), has been identified as a threatened species on the Threatened and Endangered Species list. The plants habitat has been identified as riparian areas of Colorado, specifically in riparian meadows in the City of Boulder, Boulder County and along Clear Creek in Jefferson County. RFP is located on a flat that divides two drainages feeding into Boulder County and Clear Creek. The plant has not been identified on plant site to date. No vegetative stresses attributable to hazardous waste contamination have been identified.

Animal populations within RFP are representative of western prairie regions. The presence of a chain-link fence surrounding the production area effectively limits the occurrence of the most common large mammal, the mule deer (*Odocoileus hemionus*), to the buffer zone. The permanent population of *Odocoileus hemionus* is estimated to be 100 to 125. There are a number of small carnivores, such as the coyotes (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and the long-tailed weasel (*Mustela frenata*). Small herbivores are common throughout the plant complex and buffer zone, including the pocket gopher (*Thomomys sp.*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*Microtus pennsylvanicus*) (DOE, 1980).

Commonly observed birds included horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta*), mourning doves (*Zenaidura macroura*), vesper sparrows (*Pooectes gramineus*), western kingbirds (*Tyrannus vociferans*), black-billed magpies (*Pica pica*), American robins (*Turdus migratorius*), and yellow warblers (*Dendroica magnolia*). Mallards (*Anas platyrhynochos*) and other ducks (*Anas sp.*) often nest and rear young on several of the ponds. Killdeer (*Chradrius vociferus*) and red-winged black birds (*Agelaius phoeniceus*) are found in areas adjacent to the ponds. Birds of prey commonly seen in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (DOE, 1980).

Rattlesnakes (*Crotalus sp.*) and bull snakes (*Pituophis melanoleucus*) are the most frequently appearing reptiles. Eastern yellow-bellied racers (*Coluber constrictor falviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly seen. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (DOE, 1980).

Section 9 discusses in further detail the nature and extent of threatened and endangered species in and around RFP. This section also provides a matrix with additional information regarding threatened and endangered species.

1.6.6 Surface Water Hydrology

Three Streams -- Rock Creek, Woman Creek, and Walnut Creek -- drain the RFP area and flow generally from west to east (Figure 1-8). Rock Creek, an intermittent stream, drains an area of the RFP buffer zone generally to the northwest of the RFP Controlled Area, flowing into Coal Creek offsite to the north. Coal Creek flows west and north of RFP and is joined by Rock Creek northeast of RFP. Coal Creek flows into Boulder Creek, then St. Vrain Creek, and eventually the South Platte River.

Woman Creek, a perennial stream, originates to the west of RFP, drains the southern buffer zone area, and flows westward. The South Interceptor Ditch (SID) is located between the RFP Controlled Area and Woman Creek; collects runoff from the southern part of RFP and diverts this to Pond C-2. Waters from Pond C-2 are pumped, treated, and discharged into Walnut Creek downstream of the eastern RFP boundary. Most of the remaining surface-water runoff in the Woman Creek drainage outside of the SID. Drainage flows offsite to the east and in part into Mower Reservoir and primarily into Standley Lake.

Walnut Creek is formed by the combined flows from north Walnut Creek and South Walnut Creek, which drain the central and northern areas of RFP, respectively, along with an unnamed tributary draining a northern part of the RFP area. These three tributaries join in the buffer zone, and Walnut Creek flows towards the Great Western Reservoir to the east. However, Walnut Creek flows generally are diverted around Great Western Reservoir into Big Dry Creek through the Broomfield Diversion Ditch.

Eight ditches convey water throughout the general RFP area: South Boulder Diversion Canal, Last Chance Ditch, Upper Church Ditch, McKay Ditch Bypass, Smart Ditch, Smart 2 Ditch, Mower Ditch and Kinnear Ditch. The Upper Church Ditch, McKay Ditch Bypass, Kinnear Ditch and Last Chance Ditch all divert water from Coal Creek to the east; the Smart Ditch diverts water from Rocky Flats Lake to the east; and the Smart 2 Ditch diverts water from the Smart Ditch to a Woman Creek tributary. The Mower Ditch diverts water from Woman Creek into Mower Reservoir. The South Boulder Diversion Canal is located west of RFP and is unlined in the vicinity of the RFP, except for a cement-lined 100-meter aqueduct that crosses the Woman Creek drainage. Other ditches around RFP are unlined and tend to lose water through seepage into the underlying subsurface materials.

In addition to the ditches described above, other surface-water management controls also are in operation at RFP. The West Interceptor Canal diverts runoff from the headwaters of North Walnut Creek via the McKay Ditch Bypass to Walnut Creek west of Indiana Street. In addition to ditches and canals, a series of detention ponds have been constructed to control the release of RFP discharges and to collect surface runoff.

The surface-water drainage areas from OU8 were analyzed using the information presented by Lee Wan and Associates (LWA) (1987), Wright Water Engineers, Inc. (1991) and EG&G (1991d; 1991i; 1991f). For the purposes of this analysis, the outer boundary of OU8 (EG&G, 1991e) was superimposed over the drainage-basin map (see Figure 1-9) to assess which drainage areas are located wholly or partly within the OU. From this analysis, flow paths of the runoff leaving the

OU were tracked through ditches, swales, culverts, storm sewer systems, and ponds to evaluate what areas located outside the OU8 boundary are receiving runoff originating from within the OU8 boundary.

The major drainage basins that receive runoff from OU8 are as follows:

1) North Walnut Creek, and

2) South Walnut Creek

Figure 1-9 shows the OU8 boundary with the surface-water drainage basins outlined. Figure 1-10 provides an overall schematic diagram of the RFP site area surface-water drainage system with the boundary of OU8 indicated. This Plant-site map indicates the layout of the different major drainageways and shows the location of the OU8 boundary in relation to these surface-water drainage systems. Figure 1-11 provides a schematic diagram of surface-water diversion structures at the A-series and B-series ponds.

The North Walnut Creek basin collects drainage from the northern part of the RFP Controlled Area (CA), including approximately 71 acres located within the OU8 boundary. Runoff in the upper part normally bypasses Ponds A-1 and A-2 and is collected in Pond A-3 (see Figure 1-11). Water may be diverted to Ponds A-1 and A-2 which are used exclusively for spill control (EG&G, 1991d). Pond A-4 is the terminal pond on North Walnut Creek and receives water released from Pond A-3 (EG&G, 1991f). Water from Pond A-4 is discharged to North Walnut Creek in accordance with the National Pollutant Discharge Elimination System (NPDES) permit for the Sewage Treatment Plant, the Federal Facilities Compliance Agreement (FFCA) and the Agreement in Principle (AIP) (EG&G, 1991f). North Walnut Creek is a perennial stream, whereas the tributary that carries the runoff from OU8 to North Walnut Creek is an intermittent stream, with flow occurring primarily after precipitation and snowmelt events.

The surface-water runoff leaving OU8 flows north to North Walnut Creek. Upon reaching North Walnut Creek, the runoff enters OU6 which encompasses the A-series ponds. Other OUs having IHSSs also located within the OU8 boundary are OU4, OU6, OU9, OU10, OU12, OU13, OU14, OU15, and OU16. Table 1.2 provides a listing of each OU and the associated IHSSs which are located within the boundary of OU8 (EG&G, 1991e). The OU8 IHSSs which are located within the North Walnut Creek drainage basin are listed in Table 1.3 and shown on Figure 1-12.

South Walnut Creek begins on Rocky Flats property and receives runoff from the site, including approximately 78 acres located within the OU8 boundary. This basin can be further divided into upper South Walnut Creek and lower South Walnut Creek drainage basins (LWA, 1987) (Figures 1-11 and 1-11). Lower South Walnut Creek is an intermittent stream and upper Walnut Creek is a perennial stream.

The upper South Walnut Creek drainage basin receives storm runoff from approximately 69 acres within OU8. This runoff flows through a storm sewer system and is discharged into a "natural" drainageway of South Walnut Creek near the southeast corner of the Protected Area. This drainageway flows into a storm sewer system which discharges on the east side of the Protected Area back into the natural channel . This channel then drains east to a culvert system under the Northeast Perimeter Road and into a diversion structure located just upstream from Pond B-1 (see Figure 1-11). This runoff is normally diverted around Ponds B-1, B-2, and B-3 through a bypass line to Ponds B-4, although it may be diverted into Pond B-1 (see Figure 1-11). Pond B-4 has limited storage capacity and generally passes water directly to Pond B-5 (EG&G, 1991f).

Ponds B-1 and B-2 are spill-control ponds (EG&G, 1991d) which receive water from the South Walnut Creek basin. Water levels in Pond B-1 and B-2 are kept low in order to maintain capacity for spill control. Pond B-3 collects effluent discharged via a pipeline from the STP. Excess water in Pond B-3 is discharged in accordance with provisions of the STP NPDES permit to Pond B-4 and thence to Pond B-5.

Pond B-5 is the terminal pond on South Walnut Creek. Water from Pond B-5 was historically treated and discharges to South Walnut Creek. Currently, excess water in Pond B-5 is transferred by a new pipeline to Pond A-4, where it is treated and discharged to Walnut Creek according to the NPDES permit, the FFCA and the AIP (EG&G, 1991f).

The surface-water runoff leaving OU8 flows east into OU6, which encompasses the B-series ponds located along South Walnut Creek (Figure 1-10). The OU8 IHSSs which are located within the upper South Walnut Creek sub-basin are listed in Table 1.4 and shown on Figure 1-12.

The lower South Walnut Creek drainage basin receives storm runoff from approximately 9 acres within OU8. The primary drainage structure of this drainage basin is the manmade drainage ditch along the south side of Central Avenue. Runoff from this basin is conveyed to a diversion structure located on the west side of the Northeast Perimeter Road. This runoff can be diverted north to the Upper South Walnut Creek drainage subsystem or east to south Walnut Creek between Ponds B-4 and B-5 (Figure 1-10).

1.6.7 Soils, Geology, and Hydrogeology

The geological description of OU8 was derived from the Geological Characterization Report (EG&G, 1991d) and logs of boreholes and wells. The surficial geology for the RFP and vicinity is shown in Figure 1-13. The surficial geology for OU8 specifically is shown on Figure 1-14. This figure also shows well and soil boring locations. At the RFP, core drilling and logging have been used extensively to characterize the subsurface geology. Data for selected wells and borehole logs within and immediately adjacent to OU8 are given in Table 1.5. Geologic data presented for these 75 wells and 18 boreholes includes location, type and thickness of surficial materials, elevation to the top of bedrock, and the type of bedrock intersected. Well completion, hydrologic, and geologic information for these wells and boreholes are contained in Appendices C and D.

1.6.7.1 Quaternary Geology and Soils

The RFP is located on gravelly alluvium that covers an eastward sloping pediment surface. Bedrock is exposed locally along streams that have dissected the pediment. The surficial deposits covering the pediment surface in the immediate vicinity of the RFP comprise the Rocky Flats Alluvium. The alluvium is Quaternary in age, and was deposited as an alluvial fan-shaped deposit with its apex near the mouth of Coal Creek Canyon. It is composed of poorly to moderately sorted, poorly stratified clay, silt, sand, gravel, and cobbles. The coarse clastic materials were derived primarily from Front Range provenance areas which are composed of Precambrian crystalline metaquartzites, metabasalts, pelitic schists, and younger granitoids of the Boulder Creek and Silver Plume Granites.

The Rocky Flats Alluvium is the surficial material beneath nearly all building structures at the RFP, provided it has not been removed and replaced with artificial fill. Within the RFP its thickness ranges up to 100 feet. It is absent where it has been removed by downcutting of the streams (Walnut Creek and Woman Creek) in the vicinity. The depositional surface declines approximately 300 feet from the western edge of the RFP peripheral Buffer Zone to the eastern edge of the Buffer Zone. This distance is 3.4 miles, and the slope is 88 feet per mile.

Based upon mapping by Hurr (1976), nearly all of the controlled area (CA) at the Plant is underlain by Rocky Flats Alluvium. These sediments are covered by thin soils, colluvium, artificial fill materials, and RFP structures. The Rocky Flats Alluvium ranges from slightly more than 50 feet to less than 10 feet in thickness at the CA as determined by drill core analysis. Table 1.5 lists the thickness of Rocky Flats Alluvium as intersected in core within and immediately adjacent to OU8. The thickness extremes range from 0.5 to 26.0 feet. Earthmoving for construction at RFP has locally removed all alluvial materials to bedrock. Artificial fill has been used to restore the surface to the present elevation.

Geologic materials native to the site (Rocky Flats Alluvium) and imported materials have been used as fill at the Plant for road grade and berm construction, recontouring peripheral to structures, and for surface impoundments. Artificial fill thickness have been described in drill intercepts and are tabulated in Table 1.5. Crushed rock has been used for landscaping and levelling at the site. Most of the OU8 area is covered with pavement and gravel, in addition to buildings and disturbed ground.

Local colluvial deposits are present on steeper slopes flanking drainages at the RFP. These deposits are derived from Rocky Flats Alluvium located upslope. Most bedrock is concealed beneath the colluvial material. These materials are limited at OU8 but exist in the southeastern corner as shown on Figure 1-15. Colluvium is identified in the core intercept data furnished in Table 1.5.

The bottoms of the stream valleys contain Quaternary valley-fill alluvium deposited by the streams. Minor linear wetlands are present on these alluvial materials (EG&G, 1990).

Three types of soils and their distribution have been described by the Soil Conservation Service (1983). The soils at OU8 consist of the Flatiron Series, located on Rocky Flats Alluvium; Nederland Series, commonly located on the upper slopes flanking Rocky Flats Alluvium; and Denver-Kutch-Midway Series, located on slopes flanking the previous soils. The dominant soil in the OU8 area is the Flatiron series and is mapped as shown on Figure 1.15. These soils are very cobbly sandy loams with a slow infiltration rate and are typically located on slopes of 0 to 3 percent. The next most abundant soil in the area is the Denver-Kutch-Midway Series which is restricted to the northern area and the southeastern edge of OU8. These soils are clay loams with a slow infiltration rate developed on Arapahoe Formation claystones with slopes of 9 to 25 percent. Limited areas of Nederland Series soils are present in the northwestern corner and the southeastern corner of OU8 at RFP. The Nederland soils developed adjacent to he Flatiron Series along the periphery of the Rocky Flats Alluvium where slopes are 15 to 50 percent and have a

moderate infiltration rate. Presently, all three soils are partly obscured by fill, gravel, and buildings at the RFP. No soils are distinguished in the core intercepts given in Table 1.5.

1.6.7.2 Cretaceous Geology

Figure 1-16 is a generalized stratigraphic section showing bedrock units exposed near the east edge of the Front Range in the Golden-Morrison area, a few miles south of the RFP. Figure 1-17 is a generalized stratigraphic section of the youngest units at the RFP. These units dip generally eastward, as shown in Figure 1-13, and are locally present on the surface or in the subsurface beneath the RFP.

The upper Cretaceous Arapahoe Formation unconformably underlies the surficial material at the RFP (Spencer, 1961). This formation was weathered and eroded during pedimentation and eventually covered by the Rocky Flats Alluvium. According to the Geologic Characterization Report for RFP (EG&G, 1991h), the Arapahoe Formation is 150 feet thick beneath the central portion of RFP. However, the position of the Arapahoe Formation - Laramie Formation boundary is being evaluated. Results from a recent field mapping project (EG&G, 1992h) suggest that the Arapahoe Formation is generally less that 50 feet thick. The lithologic composition is mainly claystone and silty claystone, with sandstone bodies present. Most of the sandstone is very fine to medium fine grained, poorly to moderately sorted, subangular to subrounded, silty and clayey. Some coarse-grained to conglomeratic sandstone is present. The sandstone bodies are thought to be lenticular and laterally discontinuous. The Arapahoe Formation at the RFP has been interpreted as channel, point bar and overbank deposits of a fluvial system (EG&G, 1991h).

The Laramie Formation conformably underlies the Arapahoe (Weimer, 1973). It is approximately 800 feet thick at the RFP. The formation is divided into two intervals: a lower unit of sandstone, siltstone, claystone with coal layers, and an upper claystone unit (Weimer, 1973 and EG&G, 1991a). The sandstones are fine to coarse grained, poorly sorted, subangular and silty. The

upper interval is about 500 feet thick at the RFP, consisting of light to medium gray kaolinitic claystones with some dark grey to black carbonaceous claystones (EG&G, 1991h). The Laramie Formation was deposited in a coastal or transitional marine environment.

Structurally RFP is on the western flank of the Denver Basin, approximately four miles east of steeply dipping strata on the west flank of the Front Range uplift. The generalized west to east structure beneath the RFP is shown on Figure 1-18. The most prominent feature is a monoclinal fold which strikes roughly north-south. The bedrock dips steeply eastward in the west portion of the RFP, as shown by the 50 degree dip of the Fox Hills sandstone and Laramie claystone Formations. The bedrock then flattens to a dip of no more then 1 to 2 degrees beneath the controlled area at the RFP.

There are 14 wells within OU8 in which a sandstone interval subcrops at the Arapahoe Formation - Alluvial unconformity. Listings of the lithologies which occurred in these wells is presented in Table 1.5. The uppermost subcropping sandstone in the majority of these wells is the No. 1 Sandstone, as defined by the Geological Characterization Report (EG&G, 1991h). In general, these sandstones are very fine grained to fine grained, well sorted, sub-angular to sub-rounded, moderately friable, highly weathered, and are heavily iron stained. The thickness of subcropping sandstone units ranges from 0.5 feet in well 2086 to greater then 11.5 feet in well 3186. Usually, the sandstone units are underlain by finer units such as siltstone or claystone.

The Arapahoe Formation contains several sandstone intervals. The uppermost sandstone unit is referred to in the Geological Characterization Report as the No. 1 Sandstone. The following geologic model is taken directly from that report. Figures 1-18 and 1-19 are isopach maps which present two interpretations for the No. 1 Sandstone in the OU8 area. These maps are highly interpretive since subsurface control is sparse. The first, Interpretation 1, shows a continuous single channel system. Channel and point bar deposits are both recognized; however, channel fill deposits are dominant. The second, Interpretation 2, depicts a multiple channel system containing migrated channel and point bar deposits.

Figure 1-18 also suggests that the uppermost Arapahoe Formation unit (No. 1 Sandstone) may be found as three laterally distributed channels beneath the OU8 area. Moreover Interpretation 1 presents the channel sand transport source to have emanated at one location and directed eastward in a single sinuous, tight meander belt. The sedimentation processes transporting these channel sands then re-entered the north-central area, were distributed southerly, and departed at the south-central area beneath OU8. The channel continued eastward progression and re-entered the southeast area then finally exited northeasterly, beyond the eastern side of the area beneath OU8 (EG&G, 1991h). Both pre-Wisconsin paleodrainages developing the pediment surface on Arapahoe Formation claystones and sandstones, and later headward erosion of South Walnut Creek have truncated part of the eastern-most channel sandstone (EG&G, 1991i). In the vicinity beneath IHSS 173 (east of the Mound Areas) as shown on Figure 1-18 and selected geological cross sections, partial erosion of the No. 1 Sandstone is indicated.

Figure 1-19 alternately suggests that the uppermost Arapahoe Formation unit (No. 1 Sandstone) may be found as two laterally distributed channels beneath the OU8 area. Moreover, Interpretation 2 presents these two distinct channels to have developed separately from a position west of OU8. Channel sand development and transport direction for the northerly channel continued across the northwestern area beneath OU8 and exited to the northeast. At the same time a separate the channel transported sand across the southern area beneath OU8 and exited eastward. The interpretive transport directions for these channels are also indicated on the figures. The two erosional events described at the area east of the Mound Area were applicable to the No. 1 Sandstone of Interpretation 2 and are based upon EG&G 06-27-91.

Arapahoe Formation No. 1 Sandstone tended to resist erosion relative to the erosion of the formation's claystone (EG&G, 1991h). As a consequence, certain areas beneath OU8, overlain by Rocky Flats Alluvium, are in direct contact with the underlying No. 1 Sandstone. Table 1.5 indicates that 14 of 93 wells and boreholes drilled in the area of OU8 encountered sandstone as the uppermost bedrock lithology.

Both interpretations imply lenticular geometries of individual sandstones and that the sandstones may not be in hydraulic connection laterally and vertically. (EG&G, 1991h).

Both interpretations also observe that the No. 1 Sandstone consists of more then one fining upward sequence. The Geological Characterization Report states that a minimum of three fining upward sequences are recognized where penetration of the No. 1 Sandstone is complete. Fining upward sequences and presence of the No. 1 Sandstone for wells with subcropping sandstone units is shown in Table 1.6.

Figures 1-20 through 1-24 present five geological cross sections beneath OU8. These cross sections are presented at the same scale as that in the surface maps which show the line of section (Figures 1-18 and 1-19). Sections A-A' and B-B' are generally oriented west to east while C-C', D-D', and E-E' are oriented north to south across the area of OU8. In order to graphically display subsurface geologic and hydrologic data previously collected at wells along the lines of section, the vertical scale has been exaggerated. Accordingly, the surfaces intersected such as topography, water tables, bedrock unconformity and formation boundaries are proportionately inclined greater than actual slopes interpolated to the next adjacent well providing correlative data.

Along the ground surface profile of each section, the scaled position of each IHSS intersected or in close proximity, is also indicated. Intersections or ties to other cross sections are also shown. The five sections essentially extend across the dimensions of OU8. Well screen intervals and the extremes of water level over a one year period are also indicated. Closed triangle symbols indicate the measured water level position extremes for the first hydrostratigraphic unit (HSU 1) which includes the alluvium and the hydrologically connected No. 1 Sandstone of the Arapahoe Formation. Open triangles indicate other water levels which relate to the deeper interbedded claystones, siltstones, and thin sandstones which have no direct hydrologic connection to HSU 1.

The bedrock portion of the cross-sections are based on the Geological Characterization Report, well logs given in Appendix D and Figures 1-18 and 1-19. It is assumed that the isopach maps represent sandstone bodies currently present and are not representative of channel configuration at time of deposition.

The consequence of Interpretation 1 for Arapahoe Formation No. 1 Sandstone beneath OU8 is the presence of three segments of one subsurface channel crossing beneath OU8 as previously described. Cross Sections A-A', B-B', D-D', and E-E' (Figures 1-20, 1-21, 1-23, and 1-24) show an idealized conceptual model for this interpretive channel. Cross Section B-B' shows an ideal schematic of the three channels. The units are depicted as subcropping in the central channel, but the lateral extent of the eastern channel and lateral and vertical extent of the western channels are not clearly defined. The thickest No. 1 Sandstone interval (21 feet) occurs in well P209189 as shown in Cross Sections A-A' and D-D'.

The consequence of Interpretation 2 for Arapahoe Formation No. 1 Sandstone beneath OU8 is the presence of two sandstone channels in the southeastern and northwestern portion of the unit as previously described. The thickest No. 1 Sandstone unit, found in well P209189, is in the northern channel. Other significant occurrences of No. 1 Sandstone subcropping are seen in P209389 located in the northern channel and wells BH31-87, BH32-87, and BH34-87 located in the southern channel and the southeast portion of OU8. Cross sections A-A', B-B', D-D', and E-E' show an interpretation of these sandstone channels.

It has been suggested (EG&G, 1991h) that the top of bedrock surface shows the remnants of the pre-Wisconsin pediment as well as the effects of recent stream incisement (Figure 2-25). The pediment surface was generated by streams which eroded the Arapahoe Formation bedrock and flowed west to east, imparting distinctive paleoridges and flanking paleodrainages at the RFP as shown in Figure 1-25. Immediately south of the OU8 area, the top of the bedrock beneath the Controlled Area forms a paleoridge trending east-west. Another minor paleoridge extends north-northeast in the central portion of OU8. The paleodrainages on each side of the minor paleoridge

have northeasterly gradients ranging between 10-20 feet per 1000 feet in the southwest steepening to 40-50 feet in the northeast area of OU8.

1.6.7.3 Hydrogeology

The RFP is situated in a regional groundwater recharge area. The groundwater system is dynamic. Rapid changes in water table elevations are a response to short term variations in precipitation and recharge. Generally water levels are highest in spring and early summer and lowest during the winter months. Hydrostratigraphic units that exist in the strata beneath the Rocky Flats site in the surficial materials and the underlying Cretaceous bedrock are shown in Figures 1.12 and 1.13.

The characterization of the groundwater flow regime in OU8 is based on water level measurements and well completion data from piezometers and monitoring wells. There are wells 54 and piezometers within OU8 (Table 1-6). Water levels are measured monthly in piezometers; water levels are measured monthly and groundwater samples are collected quarterly in groundwater monitoring wells. All of the wells and piezometers are either RCRA Regulatory wells or Non-regulatory Characterization wells with the exception of well 43-86 on the southeastern boundary of the OU which is a CERCLA Characterization well (EG&G, 1991c).

Hydrostratigraphic Units

The uppermost hydrostratigraphic unit (HSU 1), a water table aquifer at the RFP occurs primarily in the unconsolidated surficial material. It includes the Rocky Flats Alluvium, which is present on broad topographic highs, colluvium along valley slopes, and the Valley Fill Alluvium present in modern stream drainages. In the western part of the RFP, where the thickness of the surficial material is greatest, the depth to the water table is 50 to 70 feet below the surface. Although the water table depth is variable, it becomes shallower from west to east as the surficial material

thins. In the stream drainages, seeps are common at the base of the Rocky Flats Alluvium (EG&G, 1991k) and where individual Arapahoe Formation sandstones crop out.

Generally, the groundwater within the water table aquifer, flows along the contact of the surficial material with the Arapahoe Formation claystones in a downgradient direction to the east. The claystones have a low hydraulic conductivity, on the order of 1×10^{-7} cm/s (EG&G, 1991k), effectively constraining much of the flow within the water table aquifer to the surficial material above the bedrock unconformity. Locally, however, a hydraulic connection exists between the uppermost Arapahoe Formation sandstone and the surficial materials so that the sandstones exist as part of HSU 1 for a limited area.

The uppermost Arapahoe sandstone occurs as HSU 1 in some areas of OU8 where it outcrops and subcrops beneath the surficial material, existing in hydraulic connection with the surficial materials (Figures 1-27 and 1-28). Generally the groundwater flows along the contact of the water bearing materials and the claystones and silty claystones of the Arapahoe Formation from west to east, with minor diversions along drainages and off paleotopographic highs (paleoerosional surfaces). The saturated thickness may thin considerably during the winter months with some wells dry in the OU8 area (Table 1.7).

Other hydrostratigraphic units at the RFP includes sandstone units of the Arapahoe Formation which exist under confined conditions over most of the Rocky Flats Plant site. The confining layers for the sandstones are claystones and silty claystones. There are several bedrock monitoring wells in the OU8 area. In places where the uppermost sandstone is separated from the surficial materials by claystones and silty claystones, the sandstone may exist for a limited area as a confined aquifer. Deeper bedrock wells open to stratigraphically lower sandstones and bounded by relatively impermeable Arapahoe claystones and silty claystones exist as confined aquifers (Table 1.7). Water levels measured in bedrock wells in other areas of the RFP indicate a strong downward vertical hydraulic gradient (EG&G, 1991k). This is in keeping with the fact that the RFP site is on a topographic high and is within a regional recharge area.

The Laramie/Fox Hills aquifer crops out at the west end of the RFP and dips at 45 to 50 degrees to the east. Gradually the dip decreases to less than two degrees beneath the central part of the RFP where the Laramie/Fox Hills is separated from the RFP activities by several hundred feet of claystone (Hurr, 1976; EG&G, 1991k).

Recharge and Discharge

Groundwater recharge occurs as infiltration of precipitation to confined aquifers where bedrock crops out in the western portion of the RFP along the west limb of the monoclinal fold, and to the unconfined saturated zone through unconsolidated material and subcropping permeable bedrock throughout the RFP area (Figure 1-13). Recharge also occurs as a result of infiltration of surface water from streams, ditches, and ponds. At the local level, there are areas of discharge as well as recharge. Baseflow of some of the perennial streams is sustained by groundwater discharge. Additionally, groundwater within the surficial materials and underlying permeable bedrock (Arapahoe Formation sandstones) discharges at seeps along slopes in the valleys and becomes surface water or evaporates.

Within OU8, there are areas of recharge and discharge. Recharge as a result of incident precipitation occurs over most of the unpaved or uncovered areas of OU8, approximately less than 40 percent of the total area. Two surface drainages are present. An unnamed tributary of Walnut Creek (Figure 1-9) acts as a gaining stream (discharge area) with a baseflow contribution for most of the year as evidenced by the presence of marshes along most of its extent within the northwestern edge of OU8. South Walnut Creek is an intermittent stream, gaining during periods of high water levels and losing as a result of precipitation during periods of low water levels. Recharge to the groundwater system also occurs as a result of groundwater flow from upgradient and possibly as seepage from ponds and ditches in the area.

Hydraulic Conductivities

The Arapahoe and the surficial hydrostratigraphic units at the RFP have relatively low hydraulic conductivities and therefore, are not generally believed to be capable of producing amounts of water of economic significance (ASI, 1991, EG&G, 1991k). Hydraulic conductivity values are based on packer tests performed in 1986 and 1989. No data on hydraulic conductivity of the Arapahoe outside the RFP was discoverable.

No conclusive data are available for Recent and colluvial deposits; however, a pumping test conducted near Woman Creek in OU1 indicates a relatively high hydraulic conductivity of 1.8 x 10^{-2} cm/sec (pumping well 0-3) for the Valley Fill Alluvium (Doty, 1992b). The Draft Final Geologic Characterization Report (EG&G, 1991k) reports a range of hydraulic conductivities from 3 x 10^{-3} to 5 x 10^{-6} cm/sec for the Valley Fill Alluvium. Hydraulic conductivities reported for the Rocky Flats Alluvium of HSU 1 range from 7 x 10^{-5} cm/sec to 1 x 10^{-2} cm/sec. The reported range of hydraulic conductivities for the highly weathered and unconsolidated subcropping Arapahoe sandstone which also forms a part of HSU 1 is 2 x 10^{-6} cm/sec to 4 x 10^{-5} cm/sec. Both of these values are greater than the hydraulic conductivities of the Arapahoe claystones which are approximately 1 x 10^{-7} to 1 x 10^{-8} cm/sec for both weathered and unweathered claystone (EG&G, 1991k).

In the subsurface, confined HSU 1 in the lower Arapahoe Formation have hydraulic conductivities ranging from 4 x 10^{-8} cm/sec to 2 x 10^{-6} cm/sec. This value is intermediate to that of the hydrostratigraphic units in the Rocky Flats Alluvium and weathered subcropping Arapahoe sandstones and the Arapahoe claystones (EG&G, 1991k).

Water Level Map

Monthly water levels measured in the wells within OU8 and the surrounding area indicate that overall saturated thicknesses were greatest in April 1992 (Table 1.7). A high water level map

was generated from water levels measured in April 1992. This map is presented here as Figure 1-27. As the figure indicates, the predominant direction of groundwater flow in HSU 1 is almost due east.

Monthly water levels measured in the wells within OU8 and the surrounding area indicate that overall saturated thicknesses were the least in January 1991 (Table 1.7). A low water level map of water levels measured is presented here as Figure 1-28. This figure serves to illustrate a secondary component of groundwater flow within HSU 1. This secondary component is significant in areas of paleotopographic lows, where the direction of groundwater flow changes with respect to depth as it is being diverted around permeability barriers formed by Arapahoe Formation claystones and silty claystones present as paleoerosional highs (Figure 1-22).

TABLE 1-1

CURRENT AND PROJECTED POPULATION IN THE VICINITY OF THE ROCKY FLATS PLANT

Sector	Segment B	C	D	E	F	G	H	Sum
Year: 1989								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	22	0	283	46	50	215	616
5	300	13	25	3,671	477	578	2,355	7,419
SUM	305	48	25	3,954	523	645	2,570	8,070
Year: 2000								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	214	7	472	96	50	630	1,469
5	1,289	566	25	4,372	542	1,259	6,457	14,510
SUM	1,294	793	32	4,844	638	1,326	7,087	16,014
Year: 2010								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	5	13	0	0	0	17	0	35
4	0	389	14	644	142	50	1,007	2,246
5	2,189	1,069	25	5,009	601	1,879	10,186	20,958
SUM	2,194	1,471	39	5,653	743	1,946	11,193	23,239

Source: DOE (1991)

TABLE 1.2

Description of IHSS Contaminants and Affected Surface-Water Drainage Basins

Drainage Basin/IHSS	Contaminants	Type[1)]	Monitoring Site[2)]
I. NORTH WALNUT CREEK			Surface Sediment
•118.1 Solvent Spill, W. End of Bldg. 730	Carbon Tetrachloride Trichloroethelyene	D	SW102 SED120
•125 14,000 Gal. Holding Tank	Process Wastewater (WW) Plutonium Uranium Nitrates	A C	SW102 SED120
•126.1 Out-of Service Process Waste Tanks	Process WW Nitrates Plutonium Uranium	A C D	SW124 SED124
•126.2 Out-of Service Process Waste Tanks	Process WW Nitrates Plutonium Uranium	A C D	SW124 SED124
•127 Low Level Radioactive Waste Leak	Plutonium (LL) Nitrates	A C	SW102 SED120
•132 Radioactive Site, 700 Area Site #4, Bldg. 730	Rad. Process WW Sludge Detergent	A	SW102 SED120
•135 Cooling Tower Blowdown, S.E. of Bldg. 374	Tritium Chromium Phosphate	A B C	SW043 SED010
•137 Cooling Tower Blowdown, Bldg. 774	Chromium	B	SW102 SED120
•138 Cooling Tower Blowdown, Bldg. 779	Alpha Chromium Phosphate	A B C	SW085? None
•139.1(N) Hydroxide Tank Area (Bldg. 774)	Sodium Hydroxide	B	SW086 SED120

1) Contaminant Types:
A - Radionuclides B - Trace Metals C - Inorganics D - Volitile Organics

2) Surface-water and sediment monitoring sites which are located nearest downstream from the IHSS.

TABLE 1.2 - Continued

Description of IHSS Contaminants and Affected Surface-Water Drainage Basins

Drainage Basin/IHSS	Contaminants	Type[1)]	Monitoring Site[2)]
•139.1(S) Hydroxide Tank Area (Bldg. 771)	Potassium Hydroxide	B	SW102 SED120
•139.2 Hydrofluoric Acid Tank Area (Bldg. 714)	Hydrofluoric Acid	C	SW102 SED120
•144 Sewer Line Breaks, Bldgs. 701, 730, 779, Tanks 776 A-D	Rad. Process WW Alpha High-Level Rad. Sludge	A	SW102 SED120
•146.1 thru 146.6 Concrete Process Waste Tanks	Gross-Alpha Plutonium Uranium Caustics Acids	A B C	SW102 SED120
•149 Effluent Pipe, S.E and N. of Bldg.774	Process WW (LL Rad) Caustics Acids	A B C	SW086 SED120 SW102 SW119 SW120
•150.1 Radioactive Site, N. of Bldg. 771	Plutonium Americium Nitric Acid	A	SW084 SED124 SW124
•150.2 Radioactive Site, W. of Bldg. 771	Plutonium	A	SW018 SED010
•150.3 Radioactive Site, Between Bldgs. 771 and 774	Plutonium Process WW (LL Rad)	A	SW084 SED120 SW086 SW102
•150.7 Radioactive Site, S. of Bldg. 776	Plutonium	A	SW018 SED010
•159 Radioactive Site, E. of Bldg.559	Process WW	A	SW018 SED010
•188 Acid Leak (SE of Bldg. 374)	Hydrochloric Acid Nitric Acid	C	SW018 SED010

1) Contaminant Types:
A - Radionuclides B - Trace Metals C - Inorganics D - Volitile Organics

2) Surface-water and sediment monitoring sites which are located nearest downstream from the IHSS.

TABLE 1.2 - Continued

Description of IHSS Contaminants and Affected Surface-Water Drainage Basins

Drainage Basin/IHSS	Contaminants	Type[1)]	Monitoring Site[2)]
II. SOUTH WALNUT CREEK			
•118.2 Solvent Spill S. End of Bldg. 776	Carbon Tetrachloride Benzene Dichloromethane 1,1,1-Trichloroethane Methylethylketone Petrolium Distillates	D	SW122 SED011
•123.1 Valve Vault 7, S.W. of Bldg. 707	Process WW	A	SW122 SED011
•123.2 Valve Vault, W. of Bldg. 707	Process WW Uranium Berylium Nitric Acid Hydrofluoric Acid	A	SW122 SED011
•150.4 Radioactive Site, E. of Bldg. 750	Decon Water Plutonium (suspected)	A	SW122 SED011
•150.5 Radioactive Site, W. of Bldg. 707	Process WW Uranium Solvents Berylium Nitric Acid Fluoide	A	SW122 SED011
•150.7 Radioactive Site, S. of Bldg. 776	Plutonium	A	SW122 SED011
•159 Radioactive Site, E. of Bldg. 559	Process WW	A	SW122 SED011
•172 Central Avenue Waste Spill	Perclene Plutonium Uranium Solvent Oil Carbon Tetrachloride	A D	SW022 SW059 SED011?

1) Contaminant Types:
A - Radionuclides B - Trace Metals C - Inorganics D - Volitile Organics

2) Surface-water and sediment monitoring sites which are located nearest downstream from the IHSS.

TABLE 1.2 - Continued

Description of IHSS Contaminants and Affected Surface-Water Drainage Basins

Drainage Basin/IHSS	Contaminants	Type[1)]	Monitoring Site[2)]
•173 Radioactive Site, 900 Area	Plutonium Uranium Berylium Acetone Perchloroethane Trichloroethane	A D	SW056 SED011 SW101 SW122
•184 Radioactive Site, Bldg. 991 Steam Cleaning Area	Decon. Water (unknown)	A	SW056 SED011 SW060

1) Contaminant Types:
A - Radionuclides B - Trace Metals C - Inorganics D - Volitile Organics

2) Surface-water and sediment monitoring sites which are located nearest downstream from the IHSS.

Table 1.3
Relationship of Other OUs and IHSS's to OU8

OU Number	IHSS Number	Drainage Basin
OU4	101	North Walnut Creek
OU6[1)]	143	North Walnut Creek
OU9	121	North Walnut Creek and lower South Walnut Creek
OU10	124.1-3	North Walnut Creek
	175	upper South Walnut Creek
	176	North Walnut Creek and upper South Walnut Creek
	206	North Walnut Creek
	210	upper South Walnut Creek
OU12	147.1	upper South Walnut Creek
OU13	117.1	North Walnut Creek and upper South Walnut Creek
	117.2	upper South Walnut Creek
	128[2)]	North Walnut Creek
	137[2)]	North Walnut Creek
	158	North Walnut Creek and upper South Walnut Creek
	171[2)]	North Walnut Creek
	186	North Walnut Creek
	190	upper South Walnut Creek
OU14	156.1[2)]	North Walnut Creek
	162	North Walnut Creek and upper South Walnut Creek
OU15	215	North Walnut Creek
OU16	185	upper South Walnut Creek
	192	upper South Walnut Creek
	194	upper South Walnut Creek
	197	North Walnut Creek and upper South Walnut Creek

1) Located downstream of OU8.
2) Located within the area that drains onto OU8. Not located within the OU8 boundary.

Table 1.4

Relationship of OU8 IHSSs to Surface Water Drainage Basins

I. Drainage Basin	IHSSs	
A. North Walnut Creek	118.1	146.1 to 146.6
	125	149
	126.1	150.1
	126.2	150.2
	127	150.3
	132	150.4
	135	150.6
	137	150.8
	138	151
	139.1 (N & S)	163.1
	139.2	172
	144	188
B. upper So.Walnut Creek	118.2	150.7
	123.1	159
	123.2	172
	150.2	173
	150.4	184
	150.5	

Table 1.5
List of Wells and Boreholes at Operable Unit 08 Area
Rocky Flats Plant

Well No.	State North	State East	Surface Elevation	T.O.C. Elevation	TD	TD Elevation	Type Alluvium	Thick All.+Fill	El. Top Bedrock	Upper Bedrock	High Water Level Below Surface	High Water Level Elevation	Low Water Level Below Surface	Low Water Level Elevation	Open Interval
460	***	***	5962	***	***	***	***	***	***	***	2.60	5959.40	7.84	5954.16	***
987BR	749068	2085347	5980.22	5981.22	37.5	5,942.72	Qrf	12.70	5,967.52	***	14.83	5965.39	20.20	5960.02	***
1087	748945	2085289	5981.95	5983.52	17	5,964.95	Qrf	11.30	5,970.65	Silty Sandstone	13.05	5968.90	13.62	5968.33	3.5 - 12.1
1587	749010	2086248	5971.27	5972.79	27	5,944.27	Qrf	21.85	5,949.42	Silty Claystone	12.97	5958.30	22.84	5948.43	5.00 - 22.53
1687BR	749129	2086248	5969.49	5970.79	174	5,795.49	Qc	22.20	5,947.29	Claystone	86.46	5883.03	88.80	5880.69	99.50-125.50
1986	750,893	2,083,296	5,943.08	5,943.86	16.5	5,926.58	Qc	11.50	5,931.58	Claystone	2.34	5940.74	2.98	5940.10	2.5 - 12.5
1987	749623	2086172	5967.98	5969.91	16.1	5,951.88	Qrf	10.80	5,957.18	Silty Sandstone	6.94	5961.04	Dry	5967.98	3.00 - 12.15
2086	751112	2084358	5960.47	***	22	5,938.47	Qc	12.50	5,947.97	Clayey Sandstone	***	***	***	***	3.00 - 11.00
2087BR	749634	2086154	5968.66	5970.77	126.2	5,842.46	Qrf	11.80	5,956.86	Silty Claystone	110.49	5858.17	108.53	5860.13	105.96-116.56
2186	750,854	2,082,500	6,004.76	6005.96	78.0	5,926.76	Qrf	23.60	5,981.16	Sandy Claystone	32.67	5972.09	32.86	5971.90	35.00 - 67.24
2187	749968	2085799	5928.43	5929.69	17	5,911.43	Qrf	8.00	5,920.43	Claystone	10.24	5918.19	10.95	5917.48	3.00-11.00
2286	750718	2084410	5978.77	5979.55	266	5,712.77	Qrf	11.00	5,967.77	Sandstone	7.12	5971.65	10.61	5968.16	2.50 - 11.40
2287BR	749923	2085821	5931.18	5932.8	111	5,820.18	Qrf	12.80	5,918.38	Claystone	***	***	***	***	80.37 - 89.00
2386	750338	2084258	5982.46	5982.46	130.5	5,851.96	Qrf	8.20	5,974.26	Claystone	83.93	5898.53	93.82	5888.64	112.0 - 117.5
2387	749404	2085910	5972.79	5974.49	45.3	5,927.49	Qrf	15.25	5,957.54	Sandy Claystone	11.25	5961.54	19.26	5953.53	16.25 - 37.85
2486	750338	2084276	5982.45	5983.56	12	5,970.45	Qrf	7.20	5,975.25	Claystone	7.55	5974.90	***	***	2.50 - 7.70
2586	750411	2084830	5975.24	5977.76	89.6	5,885.64	Qrf	13.00	5,962.24	Caliche	30.43	5944.81	27.76	5947.48	66.10 - 83.60
2686	750411	2084841	5975.42	5977.17	17	5,958.42	Qrf	10.50	5,964.92	Claystone					3.1 - 12.20
2786	750780	2085237	5962.89	5963.88	157	5,805.89	Qrf	11.00	5,951.89	Claystone	80.62	5882.27	87.91	5874.98	127.0 - 135.7
2886	750802	2085239	5962.38	5964.38	15.5	5,946.88	Qrf	8.50	5,953.88	Claystone	4.75	5957.63	8.99	5953.39	2.7 - 9.7
2986	750598	2085687	5959.58	5960.68	22.5	5,937.08	Qrf	8.50	5,951.08	Claystone	7.43	5952.15	***	***	2.5 - 9.1
3086	751078	2084921	5957.42	5958.39	16	5,941.42	Qrf	2.50	5,954.92	Claystone	3.93	5953.49	5.61	5951.81	2.20 - 15.10
3186	751050	2084763	5964.98	5967.05	22	5,942.98	Qrf	0.50	5,964.48	Sandstone	Dry		Dry		2.40 - 18.30
3286	751050	2084742	5966.08	5967.92	135	5,831.08	Qrf	1.00	5,965.08	Sandstone	59.09	5906.99	54.30	5911.78	114.0 - 126.0
3386	749950	2085002	5951.4	5952.42	16.8	5,934.60	Qc	6.80	5,944.60	Claystone	5.97	5945.43	Dry	5951.40	2.50 - 7.50
3787	750493	2085223	5967.52	5968.99	15.2	5,952.32	Qrf	8.00	5,959.52	Claystone	5.92	5961.60	9.30	5958.22	3.00 -9.75
3887	705395	2085094	5972.15	5973.9	15.2	5,956.95	Qrf	7.80	5,964.35	Silty Claystone	8.47	5963.68	10.80	5961.35	3.00 - 9.75
3987BR	751080	2085268	5946.95	5948.42	138	5,808.95	0-5.2' Fill	3.50	5,943.45	Claystone					109.2 - 117.65
4386	749404	2085868	5972.91	5974.46	22	5,950.91	Qrf	17.00	5,955.91	Sandstone	12.90	5960.01	Dry	5972.91	3.00 - 16.80
4486	749,254	2,082,234	6,019.93	6,021.96	33.0	5,986.93	Qrf	25.00	5,994.93	Silty Claystone	6.25	6013.68	14.43	6005.50	2.50 - 25.60
5687	750,638	2084422	5978.39	5979.77	13.4	5964.99	Qrf	9.4	5968.99	Silty Claystone	6.93	5971.46	8.98	5969.41	3.00 - 10.20
6186	749,198	2,083,717	5,999.47	6,000.76	18.5	5,980.81	Qrf	11.50	5,987.97	Silty Claystone	8.88	5990.59	10.86	5988.61	4.0 - 12.5
BH22-87	748778	2085646	5978.5	**	27.2	5,951.30	Qrf	22.20	5,956.30	Claystone					**
BH24-87	748829	2086190	5953.6	**	12.3	5,941.30	Qc	4.90	5,948.70	Claystone					**
BH28-87	748794	2086241	5946.7	**	15	5,931.70	Qc	5.90	5,940.80	Claystone					**
BH31-87	749486	2085405	5973.8	**	15.9	5,957.90	Qrf	15.90	5,957.90	Silty Sandstone					**
BH32-87	749485	2085405	5971.7	**	20.5	5,951.20	Qrf	7.70	5,964.00	Sandstone					**
BH33-87	749488	2085766	5967.9	5969.78	20.8	5,947.10	Qrf	9.20	5,958.70	Claystone					15.00 - 20.00
BH34-87	749463	2085893	5971.4	**	24.7	5,946.70	Qrf	16.70	5,954.70	Silty Sandstone					**
BH35-87	749430	2086069	5970.5	**	20.3	5,950.20	Qrf	14.30	5,956.20	Sandy Claystone					**

Table 1.5
List of Wells and Boreholes at Operable Unit 08 Area
Rocky Flats Plant

Well No.	State North	State East	Surface Elevation	T.O.C. Elevation	TD	TD Elevation	Type Alluvium	Thick All.+Fill	El. Top Bedrock	Upper Bedrock	High Water Level Below Surface	High Water Level Elevation	Low Water Level Below Surface	Low Water Level Elevation	Open Interval
BH36-87	749502	2086149	5969.4	**	26	5,943.40	Qrf	20.60	5,948.80	Claystone					**
BH37-87	749610	2086128	5968.8	**	28	5,940.80	Qrf	14.00	5,954.80	Claystone					**
B208789	751755	2084450	5907.1	5909.03	14.4	5,892.70	Qal	4.50	5,902.60	Caliche					2.88 - 10.93
P114089	749,461	2,083,653	5,996.70	5,998.49	19.0	5,977.70	Qrf	9.30	5,987.40	Claystone					21.1 - 27.60
P114789	749,940	2,082,610	6,010.70	6,012.40	31.0	5,979.70	Qrf	26.00	5,984.70	Claystone	7.35	6003.35	11.51	5999.19	21.81 - 26.23
P114889	749,926	2,082,127	6,016.60	6,018.26	18.0	5,998.60	Qrf	13.80	6,002.80	Claystone	6.62	6009.98	7.53	6009.07	8.66 - 15.55
P115489	749,507	2,082,135	6,023.40	6,025.10	31.0	5,992.40	Qrf	26.00	5,997.40	Claystone	8.47	6014.93	13.46	6009.94	20.70 - 27.75
P115589	749,551	2,082,658	6,014.10	6,015.77	33.6	5,980.50	Qrf	29.00	5,985.10	Claystone	4.35	6009.75	10.00	6004.10	24.05 - 30.90
P115689	749,532	2,083,019	6,006.90	6,008.71	23.5	5,983.40	Qrf	19.70	5,987.20	Claystone	7.53	5999.37	14.21	5992.69	14.9 - 21.31
P207389	750195	2084468	5981.02	5982.77	23.3	5,957.72	Qrf	7.00	5,974.02	Claystone	6.48	5974.54	8.85	5972.17	9.35 - 16.40
P207489	750197	2084481	5980.71	5982.64	10	5,970.71	Qrf	6.50	5,974.21	Claystone	6.30	5974.41	8.86	5971.85	2.25 - 8.60
P207589	750395	2084843	5974.06	5975.96	29.1	5,944.96	Qrf	9.50	5,964.56	Silty Claystone	25.77	5948.29	26.50	5947.56	13.4 - 25.10
P207689	750398	2085318	5966.32	5967.88	18.2	5,948.12	Qrf	12.60	5,953.72	Silty Claystone	6.85	5959.47	8.74	5957.58	3.00 - 14.36
P207789	750392	2085343	5965.88	5967.75	32.3	5,933.58	Qrf	12.90	5,952.98	Silty Claystone	29.36	5936.52	29.94	5935.94	16.9 - 28.63
P207889	750671	2085343	5962.82	5964.9	10.5	5,952.32	Qrf	8.50	5,954.32	Claystone	4.74	5958.08	7.32	5955.50	2.5 - 8.95
P207989	750671	2085330	5963.09	5965.17	26.2	5,936.89	Qrf	5.80	5,957.29	Claystone	20.71	5942.38	21.78	5941.31	10.0 - 21.73
P208889	751086	2085249	5947.3	5949.25	105.1	5,842.20	Qc	5.50	5,941.80	Siltstone					86.75 - 99.60
P208989	751044	2084839	5962.53	5964.56	28.6	5,933.93	Qrf	3.50	5,959.03	Claystone	12.16	5950.37	17.05	5945.48	14.4 - 26.12
P209089	750,566	2084910	5972.16	5974.25	31.5	5,940.66	Qrf	11.50	5,960.66	Silty Claystone	28.03	5944.13	25.02	5947.14	15.5 - 27.21
P209189	750762	2084309	5980.66	5982.21	38.3	5,942.36	Qrf	10.30	5,970.36	Sandstone	10.18	5970.48	14.35	5966.31	12.3 - 36.08
P209289	750863	2,084,139	5,981.59	5,983.42	17.8	5,963.79	Qrf	13.80	5,967.79	Sandstone	13.73	5967.86	14.69	5966.90	7.40 - 13.40
P209389	750864	2,084,130	5,981.47	5,983.39	34.2	5,947.27	Qrf	13.80	5,967.67	Sandstone	17.15	5964.32	19.90	5961.57	15.85 - 30.10
P209489	750991	2084634	5977.98	5980.1	48	5,929.98	Qrf	9.00	5,968.98	Claystone	26.50	5951.48	29.35	5948.63	14.40 - 37.00
P209589	751071	2085286	5948.17	5950.04	30.3	5,917.87	Qrf	4.10	5,944.07	Silty Claystone	18.36	5929.81	19.27	5928.90	8.07 - 19.77
P209689	750533	2085514	5962.63	5964.43	30.2	5,932.43	Qrf	12.20	5,950.43	Sandy Claystone	28.45	5934.18	28.02	5934.61	16.2 - 27.93
P209789	750579	2085481	5962.63	5964.75	17.5	5,945.13	Qrf	12.20	5,950.43	Silty Claystone	4.70	5957.93	9.92	5952.71	2.5 - 13.75
P209889	751194	2084984	5940.28	5942.4	23.9	5,916.38	Qrf	3.90	5,936.38	Silty Claystone	4.49	5935.79	5.46	5934.82	7.90 - 19.63
P209989	751565	2084649	5898.1	5900.4	12	5,886.10	Qc	7.70	5,890.40	Silty Claystone	10.29	5887.81			2.50 - 9.58
P210089	751564	2084639	5898.4	5900.4	28	5,870.40	Qc	7.20	5,891.20	Silty Claystone	19.21	5879.19	19.06	5879.34	11.2 - 22.93
P210189	750,752	2084410	5980.82	5982.4	38.6	5,942.22	Qrf	14.60	5,966.22	Clayey Siltstone	11.97	5968.85	15.08	5965.74	19.4 - 37.13
P210289	750564	2085223	5967.03	5969.19	26	5,941.03	Qrf	6.60	5,960.43	Silty Claystone			22.36	5944.67	10.57 - 22.27
P213689	749,460	2,083,736	5,994.30	5,996.04	23.0	5,971.30	Qrf	13.00	5,981.30	Claystone	8.54	5985.76	10.03	5984.27	8.10 - 14.80
P214689	749,943	2,083,044	6,004.00	6,005.76	26.0	5,978.00	Qrf	22.00	5,982.00	Silty Claystone	8.28	5995.72	13.83	5990.17	16.55 - 23.85
P215789	749,470	2,083,430	6,002.00	6,003.66	22.0	5,980.00	Qrf	18.00	5,984.00	Claystone	13.87	5988.13	16.16	5985.84	13.00 - 19.69
P218089	749,941	2,084,020	5,985.80	5,987.55	16.0	5,969.80	Qrf	6.00	5,979.80	Claystone	5.16	5980.64	Dry		2.5 - 8.69
P218289	748,952	2,082,653	6,016.90	6,018.20	33.0	5,983.90	Qrf	23.00	5,993.90	Claystone					8.2 - 26.7
P218389	750831	2085648	5956.2	5958.45	22	5,934.20	Qrf	12.00	5,944.20	Claystone	8.83	5947.37	14.73	5941.47	7.00 - 14.00
P218489	751,127	2,084,117	5,949.10	•	5.0	5,944.10	0-5 Fill	•	•	•					•
P219189	751,222	2,084,010	5,941.20	5,943.15	21.0	5,920.20	Qrf	11.00	5,930.20	Claystone	9.77	5931.43	12.90	5928.30	6.00 - 12.9
P219489	750415	2085651	5959.5	5961.15	32	5,927.50	Qrf	22.40	5,937.10	Claystone	14.48	5945.02	20.43	5939.07	17.30 - 24.55
P219589	750268	2085536	5963.8	5965.7	16.7	5,947.10	Qrf	17.20	5,946.60	Sandstone	23.94	5939.86	26.65	5937.15	20.10 - 27.25
P313489	748,913	2,083,062	6,011.70	6,013.58	24.0	5,987.70	Qrf	20.60	5,991.10	Claystone	9.36	6002.34			15.00- 22.37

Table 1.5
List of Wells and Boreholes at Operable Unit 08 Area
Rocky Flats Plant

Well No.	State North	State East	Surface Elevation	T.O.C. Elevation	TD	TD Elevation	Type Alluvium	Thick All.+Fill	El. Top Bedrock	Upper Bedrock	High Water Level Below Surface	High Water Level Elevation	Low Water Level Below Surface	Low Water Level Elevation	Open Interval
P317989	748,891	2,084,272	5,990.90	5,992.84	16.0	5,974.90	Qrf	6.40	5,984.50	Claystone					2.5 - 9.0
P320089	748,799	2,083,280	6,009.90	6,011.87	20.9	5,989.00	Qrf	18.80	5,991.10	Silty Claystone	10.19	5999.71	15.64	5994.26	13.00 - 20.08
P414189	749,059	2,082,986	6,010.60	6,012.18	28.0	5,982.60	Qrf	18.00	5,992.60	Claystone	4.88	6005.72	10.42	6000.18	13.0 - 20.00
SP01-87	750790	2084310	5982.7	**	30.2	5,952.50	Qaf/Qrf	13.20	5,969.50	Sandstone					**
SP02-87	750970	2084640	5976.6	**	15	5,961.60	Qaf/Qrf	10.50	5,966.10	Sandstone					**
SP03-87	750480	2084630	5978.7	**	19.7	5,959.00	Qaf/Qrf	13.00	5,965.70	Claystone					**
SP04-87	750560	2084920	5971.8	**	37	5,934.80	Qrf	12.00	5,959.80	Claystone					**
SP05-87	750870	2084910	5971.6	**	21.8	5,949.80	Qrf	16.30	5,955.30	Claystone					**
SP06-87	750900	2085200	5972.9	**	30.7	5,942.20	Qaf/Qrf	18.00	5,954.90	Claystone					**
SP07-87	750471	2085200	5973.6	**	31	5,942.60	Qaf/Qrf	20.80	5,952.80	Claystone					**
SP11-87	751585	2084450	5904.5	**	34	5,870.50	Qc	21.50	5,883.00	Silty Claystone					**

Last update - 04/30/92

TABLE1.6: Geological Lithology of Selected Wells and Boreholes Located Within and Adjacent to Operable Unit 8

Well No.	Within OU8	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	(1) Presence of No. 1 Sandstone	Fining Upward Sequences	(2) Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	(3) Comments from Lithologic Logs
32-86 (Continued)						Silty Claystone	17.0	10+	Moderately weathered, slightly friable, Fe in fractures trace carbon and CaCO3, small silt lenses.
43-86	Yes	5,955.91	5.0	No. 1 SS		Sandstone	17.0	1.0	Vfg, trace silt, highly weathered, moderately friable
					Variable	Silty Sandstone	18.0	2.8	Highly weathered, moderately friable
						Sandstone	20.8	1.2	Highly weathered, slightly to moderately friable, vfg well sorted, rounded to well-rounded
P209189	Yes	5,970.36	28.0	No. 1 SS		Sandstone	10.2	7.0	Fg grading to mg (fining upward), well sorted, subangular to sub-rounded, scattered lignite
				No. 1 SS	Yes	Silty Claystone	17.0	1.0	Vfg sand - 20%
						Sandstone	18.2	1.6	Interbedded with silty claystone, fg and vfg, well-sorted, sub-angular to angular
				No. 1 SS	Yes	Silty Claystone	19.8	0.5	Vfg sand - 20%
					Yes	Silty Sandstone	20.3	1.0	Vfg, well-sorted, sub-angular to angular 80% sand
						Sandstone	21.3	5.0	Some clay, wet
				No. 1 SS		Sandstone Interbedded w/Claystone	26.3	2.0	Fg sand, wet, increasing clay content with depth
						Claystone Interbedded w/Sandstone	28.3	2.0	Vfg sand, wet, 15% sand, 85% clay
				No. 1 SS		Clayey Siltstone	30.3	2.0	Vfg sand, wet, 15% sand, 85% clay
						Sandy Claystone	33.3	1.0	Interbedded with sandy silty claystone, fg, well-sorted, Subangular, moist, 20% sand, 80% clay
						Silty Claystone	34.3	3.0+	Dry
P209289	Yes	5,967.79	4.0	No. 1 SS	Coarsening Upward	Sandstone	13.2	2.0	Damp to moist
						Claystone	15.2	2.0+	Interbedded with sandstone, vfg to fg, sub-rounded to rounded, moist
P209389	Yes	5,967.67	20.4	No. 1 SS	Coarsening Upward	Sandstone	13.8	4.4	Fg, well-sorted, subangular to angular, damp. 65% sand
						Silty Sandstone	18.2	10.2	Fg, well-sorted, subangular to sub-rounded, damp. 65% sand
						Claystone	28.4	6.0	Dry
						Silty Claystone	23.0	6.4	Weathered, iron staining, decreasing silt content with depth
						Claystone	29.4	3.6+	

Notes:
(1) Presence of No. 1 Sandstone is based on the Geological Characterization Report, Appendix A (EG&G, 1991)
(2) Lithology is based well logs found in the Geological Characterization Report, Appendix ??? (EG&G, 1991)
(3) Addtional well data is located in Table 2.1.

TABLE 1.6: Geological Lithology of Selected Wells and Boreholes Located Within and Adjacent to Operable Unit 8

Well No.	Within OU8	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	(1) Presence of No. 1 Sandstone	Fining Upward Sequences	(2) Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	(3) Comments from Lithologic Logs
10-87		5,970.65	6.7	No.1 SS	?	Silty Claystone	11.3	5.7+	Very weathered, fine to very fine, some carbonate mineralization, and black mineralization
BH-31-87	Yes	5,957.90		No. 1 SS		Silty Sandstone	7.6	2.2	Highly weathered, slightly friable, vfg
						No Sample	9.8	0.3	
				*May be bedrock		Claystone	10.1	5.9	Some caliche and silt, tr. fine sand, localized iron staining
BH 32-87	Yes	5,964.00	12.8	No. 1 SS	?	Sandstone	7.7	7.7	Silty, fg to vfg, calcareous mineralization as possible fracture fills, limonite staining, highly weathered
						Sandy Siltstone	14.7	14.7	Gradational contact, highly weathered, fg, calc. mineralization
						No Sample	15.2	15.2	
						Sandy Siltstone	15.5	15.5	Same as above, no calc. mineralization
BH 34-87		5,954.70	8.0	No. 1 SS	?	Silty Sandstone	16.7	8.0+	Gradational contact, highly weathered, highly friable, vfg, well sorted, iron-staining, possible Mg. staining.
20-86	Yes	5,938.47	9.5	Absent	?	Clayey Sandstone	12.5	.05	Sub-angular to sub-rounded, well sorted, sand is vfg - fg; abundant iron-staining
						No Sample	13.0	1.7	
						Silty Claystone	14.7	5.7	Highly weathered, mod.-poorly friable with abundant carb, Fe staining, tr sand at top of interval
22-86	Yes	5,967.77	255.	?	Coarsening Upward	Sandstone	10.5	3.5	vfg, some Fe staining, well sorted
						Silty Claystone	14.0	10+	Some Fe staining, tr. calcite, carb. material
31-86	Yes	5,964.48	21.5	No. 1 SS	?	Sandstone	0.5	11.5	Highly weathered, mod. friable, vfg, well sorted, calcareous fracture fill
						No Sample	12.0	1.0	
						Sandstone	13.0	2.0	Same as above, abundant Fe staining
						Siltstone	15.0	1.2	Highly weathered, mod. friable; trace vfg sand
						Silty Claystone	16.2	0.8	Gradational contact, highly weathered, slightly friable, Fe staining locally on fractures.
						Silty Sandstone	17.0	17.9	Highly weathered, abundant Fe staining
						Siltstone	17.9	4.1+	Highly weathered, slightly friable, tr. vfg sand, tr. clay, no water encountered while drilling
32-86	Yes	5,965.08	134	No. 1 SS	?	Sandstone	1.0	8.3	Well sorted, silt to vfg sand, grading to moderate to highly weathere Moderate to highly, thinly stratified
						Clayey Siltstone	9.3	7.7	Moderately weathered, moderately friable, some Fe staining, some carb. in fracture (90 degrees), some vfg sand

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
460	8	01-Feb-82
460	2	01-May-82
460	4	01-Aug-82
460	5	01-Dec-82
460	2	01-Jun-83
460	4.5	10-Aug-83
460	5	01-Sep-83
460	6	01-Nov-83
460	2	01-May-84
460	4	01-Jun-84
460	4	01-Mar-85
460	6.31	27-Mar-85
460	5.5	01-Jul-85
460	7.8	28-Aug-86
460	8.01	29-Aug-86
460	8.05	02-Sep-86
460	8.29	03-Sep-86
460	7.25	01-Jan-87
460	8.94	01-Feb-87
460	1.67	19-Mar-87
460	1.54	08-May-87
460	2.9	08-Jul-87
460	6.2	10-Sep-87
460	7.3	21-Oct-87
460	7.5	09-Nov-87
460	7.4	22-Dec-87
460	7.4	27-Jan-88
460	6.4	29-Feb-88
460	5.8	21-Mar-88
460	4.6	18-Apr-88
460	4.9	17-May-88
460	4.4	15-Jun-88
460	4.1	15-Jul-88
460	4.7	18-Aug-88
460	5.2	15-Sep-88
460	6	22-Oct-88
460	7	15-Nov-88
460	7.4	15-Dec-88
460	7.5	15-Jan-89
460	6	24-Feb-89
460	4.9	31-Mar-89
460	5	27-Apr-89
460	3.2	26-May-89
460	4.5	30-Jun-89
460	5.4	28-Jul-89
460	5.4	30-Aug-89
460	6.31	15-Nov-89
460	7.59	17-Jan-90
460	0.7	15-Mar-90
460	3.11	30-Apr-90
460	3.54	11-May-90
460	4.92	10-Jul-90
460	6.57	20-Aug-90
460	6.34	03-Oct-90
460	6.85	01-Nov-90
460	7.84	08-Jan-91
460	6.9	24-Apr-91
460	4.6	10-Jun-91
460	5.29	03-Jul-91
460	5.14	05-Aug-91
460	6.86	01-Oct-91
460	7.04	07-Oct-91
460	6.38	07-Jan-92
460	6.8	20-Jan-92
460	6.8	20-Jan-92
460	2.6	02-Apr-92
987	15.77	13-Apr-90
987	17.16	08-Jun-90
987	17.85	12-Jul-90
987	18.8	17-Sep-90
987	18.86	02-Oct-90
987	19.78	12-Dec-90
987	20.2	03-Jan-91
987	20.75	07-Mar-91
987	20.98	02-Apr-91
987	19.85	15-May-91
987	18.25	05-Jul-91
987	18.24	16-Aug-91
987	19.33	04-Oct-91
987	18.83	16-Dec-91
987	19.57	05-Feb-92
987	19.39	06-Mar-92
987	14.83	07-Apr-92
1087	-1	04-Aug-87
1087	13.2	09-Nov-87
1087	12.85	01-Dec-87
1087	13	21-Dec-87
1087	11.1	11-Jan-88
1087	12.9	29-Feb-88
1087	13	21-Mar-88
1087	13.1	18-Apr-88
1087	13.2	16-May-88
1087	13.4	15-Jun-88
1087	13.6	15-Jul-88
1087	13.6	18-Aug-88
1087	13.6	15-Sep-88
1087	-1	22-Oct-88
1087	-1	15-Nov-88
1087	13.6	15-Dec-88
1087	13.3	15-Jan-89
1087	12.1	14-Feb-89
1087	13	27-Apr-89
1087	13	28-May-89
1087	13.2	30-Jun-89
1087	13.55	21-Jul-89
1087	-1	25-Aug-89
1087	13.4	08-Dec-89
1087	12.98	19-Jan-90
1087	11.18	08-Mar-90
1087	13.14	13-Apr-90
1087	13.05	05-Jun-90
1087	13.56	12-Jul-90
1087	13.22	14-Aug-90
1087	13.17	17-Sep-90

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
1087	12.45	25-Sep-90
1087	12.94	02-Oct-90
1087	11.32	09-Nov-90
1087	13.08	10-Dec-90
1087	13.08	12-Dec-90
1087	13.62	03-Jan-91
1087 DRY		14-Mar-91
1087 DRY		02-Apr-91
1087	11.93	07-May-91
1087	17.86	11-Jun-91
1087	13.05	05-Jul-91
1087	12.89	08-Aug-91
1087	13.02	26-Aug-91
1087	13.6	05-Sep-91
1087	13.99	04-Oct-91
1087 DRY		04-Oct-91
1087	11.29	08-Nov-91
1087	12.96	05-Feb-92
1087 DRY		05-Mar-92
1087	13.05	07-Apr-92
1587	20.8	29-Sep-87
1587	20.4	11-Nov-87
1587	20.55	01-Dec-87
1587	20.1	21-Dec-87
1587	22.3	11-Jan-88
1587	20.2	29-Feb-88
1587	20	21-Mar-88
1587	19.6	18-Apr-88
1587	20.2	16-May-88
1587	19.2	15-Jun-88
1587	20.7	15-Jul-88
1587	21.1	18-Aug-88
1587	22	15-Sep-88
1587	22.6	22-Oct-88
1587	22.8	15-Nov-88
1587	22.8	15-Dec-88
1587	22.4	15-Jan-89
1587	21.6	14-Feb-89

Well No.	Depth from T.O.C.	DATE
1587	19.7	27-Mar-89
1587	19.8	27-Apr-89
1587	20.1	25-May-89
1587	16.7	30-Jun-89
1587	8.3	21-Jul-89
1587	19.78	25-Aug-89
1587	20.03	12-Sep-89
1587	22.1	04-Dec-89
1587	23.31	15-Jan-90
1587	22.59	23-Jan-90
1587	13.98	16-Apr-90
1587	19.32	25-Jun-90
1587	19.99	12-Jul-90
1587	20	09-Aug-90
1587	21.09	17-Sep-90
1587	21.1	18-Sep-90
1587	21.13	03-Oct-90
1587	21.65	08-Nov-90
1587	20.98	27-Nov-90
1587	21.39	04-Dec-90
1587	22.84	07-Jan-91
1587	23.72	10-Jan-91
1587	22.53	15-Apr-91
1587	20.83	03-May-91
1587	14.06	10-Jun-91
1587	17.31	03-Jul-91
1587	19.19	01-Aug-91
1587	19.58	03-Sep-91
1587	19.58	04-Sep-91
1587	20.87	01-Oct-91
1587	21.8	01-Nov-91
1587	19.24	18-Dec-91
1587	20.26	06-Jan-92
1587	20.88	03-Feb-92
1587	21.59	24-Feb-92
1587	21.93	03-Mar-92
1587	21.92	05-Mar-92
1587	12.97	06-Apr-92

Well No.	Depth from T.O.C.	DATE
1687	104.3	29-Sep-87
1687	85.2	11-Nov-87
1687	85.47	01-Dec-87
1687	85	21-Dec-87
1687	79.5	11-Jan-88
1687	76.4	29-Feb-88
1687	86.4	21-Mar-88
1687	79.5	18-Apr-88
1687	87.2	16-May-88
1687	79.6	15-Jun-88
1687	77.6	15-Jul-88
1687	81.3	15-Sep-88
1687	79.1	22-Oct-88
1687	91.9	15-Nov-88
1687	86.6	15-Dec-88
1687	78.4	15-Jan-89
1687	90.8	14-Feb-89
1687	80.8	27-Mar-89
1687	78.3	27-Apr-89
1687	78	26-May-89
1687	80.9	30-Jun-89
1687	78.48	21-Jul-89
1687	78.18	25-Aug-89
1687	94.72	16-Apr-90
1687	80.13	26-Jun-90
1687	101.34	12-Jul-90
1687	81.12	18-Sep-90
1687	102.14	03-Oct-90
1687	82.5	27-Nov-90
1687	88.8	07-Jan-91
1687	88.5	08-Jan-91
1687	80.93	15-Apr-91
1687	81.78	03-Jul-91
1687	77.83	04-Sep-91
1687	82.96	01-Oct-91
1687	81.01	20-Nov-91
1687	86.6	06-Jan-92
1687	79.8	24-Feb-92

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
1687	86.46	06-Apr-92
1986	3.95	16-Sep-86
1986	3.98	17-Sep-86
1986	4.02	18-Sep-86
1986	3.83	13-Oct-86
1986	3.37	26-Nov-86
1986	3.25	01-Jan-87
1986	2.9	25-Feb-87
1986	2.75	26-Mar-87
1986	2.75	08-May-87
1986	3.2	03-Jun-87
1986	3.2	08-Jul-87
1986	4.5	04-Aug-87
1986	3.6	10-Aug-87
1986	3.4	03-Sep-87
1986	3.5	14-Sep-87
1986	3.1	28-Oct-87
1986	3.1	09-Nov-87
1986	3.1	17-Nov-87
1986	3.3	22-Dec-87
1986	2.6	01-Feb-88
1986	2.9	29-Feb-88
1986	2.9	21-Mar-88
1986	2.8	18-Apr-88
1986	3.3	16-May-88
1986	3.5	15-Jun-88
1986	3.4	15-Jul-88
1986	3.4	18-Aug-88
1986	3.5	15-Sep-88
1986	3.4	22-Oct-88
1986	3.1	15-Nov-88
1986	2.9	15-Dec-88
1986	2.9	15-Jan-89
1986	2.5	24-Feb-89
1986	2.2	31-Mar-89
1986	3.1	27-Apr-89
1986	2.6	25-May-89
1986	3.4	30-Jun-89
1986	3.58	28-Jul-89
1986	3.57	30-Aug-89
1986	3.07	12-Sep-89
1986	2.98	03-Nov-89
1986	2.96	18-Jan-90
1986	2.81	12-Feb-90
1986	2.41	25-Apr-90
1986	2.85	09-May-90
1986	3.19	11-Jul-90
1986	3.15	25-Jul-90
1986	3.35	15-Aug-90
1986	3.53	04-Sep-90
1986	3.28	03-Oct-90
1986	3.24	18-Oct-90
1986	3.12	02-Nov-90
1986	2.98	04-Jan-91
1986	2.16	03-Jun-91
1986	2.16	03-Jun-91
1986	2.67	03-Jul-91
1986	3.06	31-Jul-91
1986	2.89	05-Aug-91
1986	3.01	04-Sep-91
1986	3.01	01-Oct-91
1986	3.15	02-Oct-91
1986	2.84	04-Nov-91
1986	2.57	03-Dec-91
1986	2.71	07-Jan-92
1986	2.55	30-Jan-92
1986	2.68	06-Feb-92
1986	2.78	02-Mar-92
1986	2.34	02-Apr-92
1986	2.53	08-Apr-92
1987	7.8	09-Nov-87
1987	11.77	01-Dec-87
1987	7.5	21-Dec-87
1987	13.3	11-Jan-88
1987	12.6	29-Feb-88
1987	12.7	21-Mar-88
1987	12.6	18-Apr-88
1987	12.7	16-May-88
1987	11.8	15-Jun-88
1987	12.8	15-Jul-88
1987	13.4	18-Aug-88
1987	12.5	15-Sep-88
1987	-1	22-Oct-88
1987	13.6	15-Nov-88
1987	-1	15-Dec-88
1987	-1	15-Jan-89
1987	-1	24-Feb-89
1987	-1	31-Mar-89
1987	-1	27-Apr-89
1987	-1	26-May-89
1987	12.1	30-Jun-89
1987	12.9	28-Jul-89
1987	-1	30-Aug-89
1987	-1	12-Sep-89
1987	-1	04-Dec-89
1987	-1	15-Jan-90
1987	13.54	12-Apr-90
1987	12.41	22-May-90
1987	12.98	10-Jul-90
1987	13.25	25-Jul-90
1987 DRY		01-Oct-90
1987 DRY		07-Nov-90
1987 DRY		02-Jan-91
1987 DRY		02-Jan-91
1987 DRY		02-Apr-91
1987	11.19	02-Jul-91
1987	12.85	14-Aug-91
1987	13.93	04-Oct-91
1987 DRY		04-Oct-91
1987 DRY		03-Jan-92
1987	6.94	06-Apr-92
2087	108.5	29-Sep-87
2087	112.5	09-Nov-87
2087	108.91	01-Dec-87

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2087	112.2	21-Dec-87
2087	101.6	11-Jan-88
2087	98	29-Feb-88
2087	113.7	21-Mar-88
2087	108.5	18-Apr-88
2087	115.3	16-May-88
2087	109.9	15-Jun-88
2087	105.5	15-Jul-88
2087	103.7	18-Aug-88
2087	106.9	15-Sep-88
2087	104.7	22-Oct-88
2087	113.4	15-Nov-88
2087	111.1	15-Dec-88
2087	103.8	15-Jan-89
2087	112	24-Feb-89
2087	106.9	31-Mar-89
2087	104.1	27-Apr-89
2087	103.6	25-May-89
2087	105.5	30-Jun-89
2087	102.7	28-Jul-89
2087	101.67	30-Aug-89
2087	108.28	12-Apr-90
2087	103.95	22-May-90
2087	108.89	10-Jul-90
2087	106.85	27-Jul-90
2087	107.58	01-Oct-90
2087	103.62	08-Nov-90
2087	108.53	02-Jan-91
2087	101.02	18-Mar-91
2087	114.79	02-Apr-91
2087	108.86	09-May-91
2087	108.86	09-May-91
2087	109.78	02-Jul-91
2087	104.69	14-Aug-91
2087	109.58	04-Oct-91
2087	102.75	05-Dec-91
2087	112.31	03-Jan-92
2087	105.54	24-Feb-92
2087	110.49	06-Apr-92
2186	-1	29-Aug-86
2186	49.23	19-Nov-86
2186	45.5	20-Nov-86
2186	44.01	21-Nov-86
2186	38.79	24-Nov-86
2186	41.26	25-Nov-86
2186	32.79	01-Jan-87
2186	32.6	25-Feb-87
2186	32.58	25-Mar-87
2186	32.4	08-May-87
2186	32.47	03-Jun-87
2186	33	08-Jul-87
2186	32.5	04-Aug-87
2186	33	03-Sep-87
2186	33.1	14-Sep-87
2186	33.3	06-Oct-87
2186	33.3	09-Nov-87
2186	33.3	17-Nov-87
2186	33.1	22-Dec-87
2186	33.1	01-Feb-88
2186	32.9	29-Feb-88
2186	32.9	21-Mar-88
2186	32.9	18-Apr-88
2186	32.9	17-May-88
2186	33.1	15-Jun-88
2186	33.3	15-Jul-88
2186	33.3	18-Aug-88
2186	33.9	15-Sep-88
2186	33.7	22-Oct-88
2186	34.7	15-Nov-88
2186	33.7	15-Dec-88
2186	33.1	15-Jan-89
2186	32.9	24-Feb-89
2186	33	31-Mar-89
2186	32.8	27-Apr-89
2186	32.8	26-May-89
2186	32.9	30-Jun-89
2186	32.85	28-Jul-89
2186	32.99	30-Aug-89
2186	33.54	12-Sep-89
2186	32.9	07-Nov-89
2186	32.69	18-Jan-90
2186	32.36	28-Feb-90
2186	32.27	25-Apr-90
2186	32.18	11-May-90
2186	32.48	11-Jul-90
2186	32.56	02-Aug-90
2186	32.88	02-Oct-90
2186	32.81	06-Nov-90
2186	32.86	04-Jan-91
2186	32.91	03-Jun-91
2186	33.2	03-Jul-91
2186	33.21	08-Aug-91
2186	33.36	01-Oct-91
2186	33.35	15-Oct-91
2186	32.92	07-Jan-92
2186	32.72	28-Jan-92
2186	32.67	02-Apr-92
2187	7.3	12-Nov-87
2187	-1	01-Dec-87
2187	7.2	22-Dec-87
2187	7.4	27-Jan-88
2187	7.1	29-Feb-88
2187	8.4	21-Mar-88
2187	7.8	18-Apr-88
2187	8.8	17-May-88
2187	9.7	15-Jun-88
2187	8.5	15-Jul-88
2187	8	18-Aug-88
2187	7.9	15-Sep-88
2187	7.6	22-Oct-88
2187	9.5	15-Nov-88
2187	9.4	15-Dec-88
2187	9.2	15-Jan-89
2187	8.6	24-Feb-89

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2187	9	31-Mar-89
2187	5.6	27-Apr-89
2187	5.4	25-May-89
2187	6.4	30-Jun-89
2187	6.11	28-Jul-89
2187	5.94	30-Aug-89
2187	8.01	11-Sep-89
2187	7.05	10-Nov-89
2187	10.35	17-Jan-90
2187	9.69	06-Feb-90
2187	8.33	24-Apr-90
2187	7.5	18-May-90
2187	8.69	10-Jul-90
2187	6.42	05-Sep-90
2187	10.29	01-Oct-90
2187	8.96	11-Dec-90
2187	10.95	04-Jan-91
2187	7.93	23-Apr-91
2187	8.97	10-Jun-91
2187	10.27	03-Jul-91
2187	8.52	05-Aug-91
2187	8.7	01-Oct-91
2187	8.41	16-Oct-91
2187	9.71	08-Jan-92
2187	9.56	15-Jan-92
2187	9.08	26-Feb-92
2187	10.24	02-Apr-92
2286	8.38	12-Sep-86
2286	8.52	13-Sep-86
2286	8.25	15-Sep-86
2286	8.22	16-Sep-86
2286	8.28	17-Sep-86
2286	8.22	19-Sep-86
2286	7.22	13-Oct-86
2286	7.35	26-Nov-86
2286	8.5	01-Jan-87
2286	7.29	25-Feb-87
2286	6.17	24-Mar-87
2286	5.71	08-May-87
2286	6.8	03-Jun-87
2286	6.25	08-Jul-87
2286	6.8	04-Aug-87
2286	5.6	27-Aug-87
2286	5.9	03-Sep-87
2286	8	21-Oct-87
2286	8.4	09-Nov-87
2286	8	21-Dec-87
2286	6.6	11-Jan-88
2286	7.3	29-Feb-88
2286	7.2	21-Mar-88
2286	6.7	18-Apr-88
2286	7	17-May-88
2286	6.7	15-Jun-88
2286	7	15-Jul-88
2286	7.7	18-Aug-88
2286	7.7	15-Sep-88
2286	8.1	22-Oct-88
2286	9.4	15-Nov-88
2286	9.5	15-Dec-88
2286	9.6	15-Jan-89
2286	8.2	24-Feb-89
2286	7.6	31-Mar-89
2286	7.5	27-Apr-89
2286	5.9	25-May-89
2286	7.3	30-Jun-89
2286	8.22	28-Jul-89
2286	7.04	30-Aug-89
2286	6.62	11-Sep-89
2286	8.33	06-Nov-89
2286	10.26	17-Jan-90
2286	10.54	16-Feb-90
2286	7.34	25-Apr-90
2286	7.6	09-May-90
2286	8.86	11-Jul-90
2286	7.87	27-Jul-90
2286	8.37	02-Oct-90
2286	8.66	12-Oct-90
2286	10.61	04-Jan-91
2286	10.75	07-Jan-91
2286	7.6	29-May-91
2286	8.21	03-Jul-91
2286	8.52	30-Jul-91
2286	9.75	01-Oct-91
2286	9.74	03-Oct-91
2286	9.79	07-Jan-92
2286	9.98	09-Jan-92
2286	7.12	02-Apr-92
2287BR	80.8	11-Sep-89
2287BR	80.45	10-Nov-89
2287BR	78.7	17-Jan-90
2287BR	80.3	08-Feb-90
2386	107.75	01-Oct-86
2386	91.79	17-Nov-86
2386	113.25	18-Nov-86
2386	115.61	19-Nov-86
2386	113.22	25-Nov-86
2386	93.92	01-Jan-87
2386	79.25	25-Feb-87
2386	73	18-Mar-87
2386	104.38	08-May-87
2386	94.02	03-Jun-87
2386	113.05	08-Jul-87
2386	98.6	04-Aug-87
2386	87.8	03-Sep-87
2386	87.8	23-Sep-87
2386	95.1	28-Oct-87
2386	94.9	09-Nov-87
2386	94.5	21-Dec-87
2386	95	29-Feb-88
2386	89.7	21-Mar-88
2386	104.9	18-Apr-88
2386	93.6	17-May-88
2386	103.6	15-Jun-88
2386	93	15-Jul-88

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2386	88.5	18-Aug-88
2386	105.9	15-Sep-88
2386	98.1	22-Oct-88
2386	26.1	15-Nov-88
2386	105	15-Dec-88
2386	79.5	24-Feb-89
2386	78.1	31-Mar-89
2386	89.1	27-Apr-89
2386	55.67	12-Sep-89
2386	47.2	06-Nov-89
2386	91.42	17-Jan-90
2386	71.81	22-Mar-90
2386	102.96	25-Apr-90
2386	91.55	25-May-90
2386	97.17	11-Jul-90
2386	85.45	13-Aug-90
2386	95.27	02-Oct-90
2386	80.73	14-Nov-90
2386	93.82	04-Jan-91
2386	62.56	24-Apr-91
2386	101.51	30-May-91
2386	103.44	03-Jul-91
2386	92.27	31-Jul-91
2386	91.22	01-Oct-91
2386	89.08	07-Oct-91
2386	79.5	13-Jan-92
2386	83.93	02-Apr-92
2387	17.7	29-Sep-87
2387	18.4	09-Nov-87
2387	16.1	01-Dec-87
2387	18.1	21-Dec-87
2387	18.2	11-Jan-88
2387	16.5	29-Feb-88
2387	16.4	21-Mar-88
2387	15.5	18-Apr-88
2387	16.6	16-May-88
2387	16.6	15-Jun-88
2387	14.7	15-Jul-88

Well No.	Depth from T.O.C.	DATE
2387	18	18-Aug-88
2387	17.9	15-Sep-88
2387	18.9	22-Oct-88
2387	19.6	15-Nov-88
2387	19.7	15-Dec-88
2387	19.3	15-Jan-89
2387	16.5	24-Feb-89
2387	17	27-Mar-89
2387	17.1	27-Apr-89
2387	17.1	25-May-89
2387	15.4	30-Jun-89
2387	17.85	28-Jul-89
2387	17.37	30-Aug-89
2387	12.17	12-Apr-90
2387	15.52	01-Jun-90
2387	17.63	10-Jul-90
2387	33.68	13-Aug-90
2387	17.9	01-Oct-90
2387	17.62	09-Nov-90
2387	19.26	02-Jan-91
2387	18.96	08-Mar-91
2387	19.23	02-Apr-91
2387	17.41	19-Apr-91
2387	15.28	02-Jul-91
2387	15.22	19-Aug-91
2387	18.53	04-Oct-91
2387	15.56	23-Nov-91
2387	17.13	03-Jan-92
2387	19.73	28-Feb-92
2387	11.25	06-Apr-92
2486	-1	16-Sep-86
2486	-1	13-Oct-86
2486	-1	26-Nov-86
2486	-1	01-Jan-87
2486	-1	25-Feb-87
2486	-1	18-Mar-87
2486	-1	08-May-87
2486	-1	03-Jun-87

Well No.	Depth from T.O.C.	DATE
2486	8.65	08-Jul-87
2486	-1	04-Aug-87
2486	-1	03-Sep-87
2486	-1	24-Sep-87
2486	-1	28-Oct-87
2486	-1	09-Nov-87
2486	-1	21-Dec-87
2486	-1	11-Jan-88
2486	-1	29-Feb-88
2486	-1	21-Mar-88
2486	8.7	18-Apr-88
2486	8.2	15-Jun-88
2486	-1	15-Jul-88
2486	8.7	18-Aug-88
2486	8.7	15-Sep-88
2486	-1	22-Oct-88
2486	-1	15-Nov-88
2486	8.7	15-Dec-88
2486	8.4	15-Jan-89
2486	-1	24-Feb-89
2486	-1	31-Mar-89
2486	-1	27-Apr-89
2486	8.7	26-May-89
2486	-1	30-Jun-89
2486	-1	28-Jul-89
2486	-1	30-Aug-89
2486	8.58	11-Sep-89
2486	-1	06-Nov-89
2486	-1	17-Jan-90
2486	8.55	25-Apr-90
2486 DRY		20-May-90
2486 DRY		11-Jul-90
2486 DRY		10-Aug-90
2486 DRY		22-Aug-90
2486 DRY		05-Sep-90
2486 DRY		02-Oct-90
2486 DRY		01-Nov-90
2486 DRY		02-Nov-90

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2486	**.**	04-Jan-91
2486	DRY	24-Apr-91
2486	7.36	07-Jun-91
2486	7.51	11-Jun-91
2486	DRY	03-Jul-91
2486	DRY	02-Aug-91
2486	DRY	04-Sep-91
2486	9.11	01-Oct-91
2486	DRY	01-Oct-91
2486	DRY	04-Nov-91
2486	7.54	03-Dec-91
2486	DRY	07-Jan-92
2486	8.65	06-Feb-92
2486	DRY	02-Mar-92
2486	7.55	02-Apr-92
2586	71.05	30-Sep-86
2586	77.93	01-Oct-86
2586	71.42	13-Oct-86
2586	76.73	21-Oct-86
2586	74.59	28-Oct-86
2586	74.24	05-Nov-86
2586	78.65	06-Nov-86
2586	79.52	07-Nov-86
2586	71.94	26-Nov-86
2586	31.83	01-Jan-87
2586	23.92	25-Feb-87
2586	21.75	18-Mar-87
2586	35.38	08-May-87
2586	27.25	03-Jun-87
2586	71.7	08-Jul-87
2586	24.7	04-Aug-87
2586	32.6	27-Aug-87
2586	31.4	03-Sep-87
2586	28.6	09-Nov-87
2586	28.4	21-Dec-87
2586	21	11-Jan-88
2586	34.6	29-Feb-88
2586	27.8	21-Mar-88
2586	40.7	18-Apr-88
2586	28.6	17-May-88
2586	45.2	15-Jun-88
2586	31	15-Jul-88
2586	27.3	18-Aug-88
2586	58.1	15-Sep-88
2586	41.6	22-Oct-88
2586	27.8	15-Nov-88
2586	72.6	15-Dec-88
2586	34.5	15-Jan-89
2586	27.6	24-Feb-89
2586	25.9	31-Mar-89
2586	35.9	27-Apr-89
2586	29.4	26-May-89
2586	41.5	30-Jun-89
2586	30.31	28-Jul-89
2586	25.15	30-Aug-89
2586	67.23	11-Sep-89
2586	35.52	08-Nov-89
2586	30.75	17-Jan-90
2586	24.4	22-Feb-90
2586	35	24-Apr-90
2586	26.87	25-May-90
2586	41.52	10-Jul-90
2586	26.16	28-Aug-90
2586	48.15	01-Oct-90
2586	42.19	10-Oct-90
2586	28.18	04-Jan-91
2586	27.76	07-Jan-91
2586	22.58	10-Jun-91
2586	60.32	03-Jul-91
2586	44.22	23-Jul-91
2586	32.77	01-Oct-91
2586	29.38	15-Oct-91
2586	28.74	07-Jan-92
2586	26.25	22-Jan-92
2586	26.25	22-Jan-92
2586	30.43	03-Apr-92
2786	111.22	30-Sep-86
2786	130.6	01-Oct-86
2786	130.48	13-Oct-86
2786	129.41	17-Oct-86
2786	127.5	21-Oct-86
2786	124.17	28-Oct-86
2786	123.1	05-Nov-86
2786	131.6	07-Nov-86
2786	115.94	26-Nov-86
2786	78.71	01-Jan-87
2786	99.04	25-Feb-87
2786	61.25	19-Mar-87
2786	107.04	08-May-87
2786	88.22	03-Jun-87
2786	115.15	08-Jul-87
2786	92.4	04-Aug-87
2786	74.5	03-Sep-87
2786	67.6	22-Sep-87
2786	100.7	21-Oct-87
2786	87.1	09-Nov-87
2786	70.1	22-Dec-87
2786	82.8	27-Jan-88
2786	70.5	29-Feb-88
2786	64.4	21-Mar-88
2786	99.3	18-Apr-88
2786	79.4	17-May-88
2786	95	15-Jun-88
2786	77.1	15-Jul-88
2786	71.8	18-Aug-88
2786	109.6	15-Sep-88
2786	91.5	22-Oct-88
2786	73.9	15-Nov-88
2786	123.5	15-Dec-88
2786	84.8	15-Jan-89
2786	74	24-Feb-89
2786	70.6	31-Mar-89
2786	85.2	27-Apr-89
2786	75.9	26-May-89

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2786	90.5	30-Jun-89
2786	76.4	28-Jul-89
2786	67.29	30-Aug-89
2786	63.44	11-Sep-89
2786	85.42	30-Oct-89
2786	81.82	17-Jan-90
2786	71.11	13-Feb-90
2786	79.2	24-Apr-90
2786	126.5	14-May-90
2786	86.08	10-Jul-90
2786	75.43	03-Aug-90
2786	83.56	01-Oct-90
2786	67.61	13-Nov-90
2786	87.91	04-Jan-91
2786	57.35	24-Apr-91
2786	94.65	10-Jun-91
2786	110.92	03-Jul-91
2786	95.12	23-Jul-91
2786	80.12	01-Oct-91
2786	77.16	08-Oct-91
2786	71.77	07-Jan-92
2786	66.31	27-Jan-92
2786	80.62	02-Apr-92
2886	10.54	12-Sep-86
2886	10.67	13-Sep-86
2886	10.36	15-Sep-86
2886	10.78	16-Sep-86
2886	10.8	17-Sep-86
2886	10.63	18-Sep-86
2886	9.1	13-Oct-86
2886	8.51	26-Nov-86
2886	8.79	01-Jan-87
2886	7	25-Feb-87
2886	3.25	19-Mar-87
2886	4.38	08-May-87
2886	5.73	03-Jun-87
2886	5.65	08-Jul-87
2886	7.4	04-Aug-87
2886	8	03-Sep-87
2886	8.9	21-Oct-87
2886	8.7	09-Nov-87
2886	8.7	22-Dec-87
2886	5.8	27-Jan-88
2886	5.6	29-Feb-88
2886	5.8	21-Mar-88
2886	5.7	18-Apr-88
2886	6.3	17-May-88
2886	6.1	15-Jun-88
2886	6.2	15-Jul-88
2886	6.5	18-Aug-88
2886	6.8	15-Sep-88
2886	7.5	22-Oct-88
2886	8.4	15-Nov-88
2886	8.5	15-Dec-88
2886	8.8	15-Jan-89
2886	7.9	24-Feb-89
2886	7.9	31-Mar-89
2886	7.3	27-Apr-89
2886	6.2	26-May-89
2886	6	30-Jun-89
2886	7.03	28-Jul-89
2886	7.13	30-Aug-89
2886	5.42	11-Sep-89
2886	7.2	30-Oct-89
2886	8.5	17-Jan-90
2886	8.75	13-Feb-90
2886	4.9	24-Apr-90
2886	5.7	15-May-90
2886	6.78	10-Jul-90
2886	6.84	03-Aug-90
2886	7.14	10-Aug-90
2886	7.61	05-Sep-90
2886	8.06	01-Oct-90
2886	8.61	02-Nov-90
2886	7.51	13-Nov-90
2886	8.99	04-Jan-91
2886	8.43	23-Apr-91
2886	5.99	07-Jun-91
2886	6.13	10-Jun-91
2886	6.98	03-Jul-91
2886	7.38	23-Jul-91
2886	7.48	02-Aug-91
2886	7.95	04-Sep-91
2886	8.48	01-Oct-91
2886	8.65	09-Oct-91
2886	8.95	01-Nov-91
2886	7.45	03-Dec-91
2886	8.11	07-Jan-92
2886	8.34	27-Jan-92
2886	8.46	06-Feb-92
2886	8.9	02-Mar-92
2886	4.75	02-Apr-92
2986	-1	12-Sep-86
2986	-1	24-Sep-86
2986	-1	13-Oct-86
2986	-1	26-Nov-86
2986	-1	01-Jan-87
2986	-1	25-Feb-87
2986	-1	19-Mar-87
2986	8.85	08-May-87
2986	9.82	03-Jun-87
2986	-1	08-Jul-87
2986	-1	04-Aug-87
2986	-1	03-Sep-87
2986	-1	21-Oct-87
2986	-1	09-Nov-87
2986	-1	22-Dec-87
2986	-1	27-Jan-88
2986	-1	29-Feb-88
2986	-1	21-Mar-88
2986	-1	18-Apr-88
2986	8.3	15-Jun-88
2986	10.2	15-Jul-88
2986	-1	18-Aug-88

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
2986	10.2	15-Sep-88
2986	-1	22-Oct-88
2986	-1	15-Nov-88
2986	-1	15-Dec-88
2986	-1	15-Jan-89
2986	-1	24-Feb-89
2986	-1	31-Mar-89
2986	10.2	27-Apr-89
2986	10.1	26-May-89
2986	10	30-Jun-89
2986	-1	28-Jul-89
2986	-1	30-Aug-89
2986	-1	11-Sep-89
2986	-1	30-Oct-89
2986	-1	17-Jan-90
2986	7.65	24-Apr-90
2986	8.82	16-May-90
2986 DRY		10-Jul-90
2986 DRY		02-Aug-90
2986 DRY		10-Aug-90
2986 DRY		05-Sep-90
2986 DRY		01-Oct-90
2986 DRY		19-Oct-90
2986 DRY		02-Nov-90
2986 DRY		04-Jan-91
2986 DRY		04-Jan-91
2986	8.96	07-Jun-91
2986	9.05	10-Jun-91
2986 DRY		03-Jul-91
2986 DRY		02-Aug-91
2986 DRY		04-Sep-91
2986	10.6	01-Oct-91
2986 DRY		01-Oct-91
2986 DRY		04-Nov-91
2986 DRY		03-Dec-91
2986 DRY		07-Jan-92
2986 DRY		06-Feb-92
2986 DRY		02-Mar-92
2986	7.43	02-Apr-92
3086	12.33	12-Sep-86
3086	11.94	13-Sep-86
3086	8.67	15-Sep-86
3086	9.67	16-Sep-86
3086	8.87	17-Sep-86
3086	8.66	18-Sep-86
3086	8.14	19-Sep-86
3086	5.07	13-Oct-86
3086	6.21	26-Nov-86
3086	9.33	01-Jan-87
3086	5.9	25-Feb-87
3086	4.58	23-Mar-87
3086	4.79	08-May-87
3086	5.62	03-Jun-87
3086	5.7	08-Jul-87
3086	6.5	04-Aug-87
3086	6.1	03-Sep-87
3086	6.1	23-Sep-87
3086	6.4	21-Oct-87
3086	6.5	09-Nov-87
3086	6.5	17-Nov-87
3086	6.4	22-Dec-87
3086	5.9	01-Feb-88
3086	5.1	29-Feb-88
3086	5	21-Mar-88
3086	4.9	18-Apr-88
3086	5.3	15-Jun-88
3086	5.8	15-Jul-88
3086	5.9	18-Aug-88
3086	5.7	15-Sep-88
3086	5.6	22-Oct-88
3086	5.8	15-Nov-88
3086	5.4	15-Dec-88
3086	6.2	15-Jan-89
3086	5.5	24-Feb-89
3086	4.1	31-Mar-89
3086	4.4	27-Apr-89
3086	4.4	26-May-89
3086	4.5	30-Jun-89
3086	5.35	28-Jul-89
3086	5.45	30-Aug-89
3086	5.29	12-Sep-89
3086	5.47	08-Nov-89
3086	5.6	17-Jan-90
3086	5.53	07-Feb-90
3086	4.58	25-Apr-90
3086	5.01	31-May-90
3086	5.65	10-Jul-90
3086	5.42	14-Aug-90
3086	6.17	02-Oct-90
3086	5.61	04-Jan-91
3086	5.35	29-Apr-91
3086	3.95	29-May-91
3086	4.93	05-Jul-91
3086	5.85	06-Aug-91
3086	4.85	01-Oct-91
3086	6.73	10-Oct-91
3086	6.07	07-Jan-92
3086	5.78	28-Jan-92
3086	3.93	02-Apr-92
3186	-1	12-Sep-86
3186	-1	13-Oct-86
3186	-1	09-Nov-86
3186	-1	26-Nov-86
3186	-1	01-Jan-87
3186	-1	25-Feb-87
3186	-1	23-Mar-87
3186	-1	08-May-87
3186	-1	03-Jun-87
3186	-1	08-Jul-87
3186	-1	04-Aug-87
3186	-1	03-Sep-87
3186	-1	24-Sep-87
3186	-1	21-Oct-87
3186	-1	09-Nov-87

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
3186	-1	22-Dec-87
3186	-1	01-Feb-88
3186	-1	29-Feb-88
3186	-1	21-Mar-88
3186	-1	18-Apr-88
3186	16.9	15-Jun-88
3186	-1	15-Jul-88
3186	-1	18-Aug-88
3186	-1	15-Sep-88
3186	-1	22-Oct-88
3186	-1	15-Nov-88
3186	-1	15-Dec-88
3186	-1	15-Jan-89
3186	-1	24-Feb-89
3186	-1	31-Mar-89
3186	-1	27-Apr-89
3186	19.4	26-May-89
3186	-1	30-Jun-89
3186	-1	28-Jul-89
3186	-1	30-Aug-89
3186	-1	12-Sep-89
3186	-1	14-Nov-89
3186	-1	17-Jan-90
3186 DRY		25-Apr-90
3186 DRY		07-May-90
3186 DRY		10-Jul-90
3186 DRY		25-Jul-90
3186 DRY		02-Oct-90
3186 DRY		25-Oct-90
3186 DRY		04-Jan-91
3186 DRY		04-Jan-91
3186 DRY		11-Jun-91
3186 DRY		03-Jul-91
3186	19.7	01-Oct-91
3186 DRY		01-Oct-91
3186 DRY		08-Jan-92
3186 DRY		02-Apr-92
3286	54	22-Sep-86
3286	66.34	13-Oct-86
3286	103.5	17-Oct-86
3286	101.52	21-Oct-86
3286	89.67	28-Oct-86
3286	89.2	04-Nov-86
3286	112.6	05-Nov-86
3286	119.77	06-Nov-86
3286	115.89	07-Nov-86
3286	72.32	26-Nov-86
3286	54.92	01-Jan-87
3286	53.77	25-Feb-87
3286	53.33	23-Mar-87
3286	110	24-Mar-87
3286	64.33	08-May-87
3286	55.74	03-Jun-87
3286	82.1	08-Jul-87
3286	57	04-Aug-87
3286	54.4	03-Sep-87
3286	58.3	21-Oct-87
3286	54.4	09-Nov-87
3286	54.4	17-Nov-87
3286	54.1	22-Dec-87
3286	54.8	01-Feb-88
3286	54	29-Feb-88
3286	54.7	21-Mar-88
3286	57.2	18-Apr-88
3286	55.7	15-Jun-88
3286	54.3	15-Jul-88
3286	53.8	18-Aug-88
3286	61.7	15-Sep-88
3286	55.8	22-Oct-88
3286	54.1	15-Nov-88
3286	74.5	15-Dec-88
3286	54.5	15-Jan-89
3286	53.7	24-Feb-89
3286	53.5	31-Mar-89
3286	54.7	27-Apr-89
3286	53.8	26-May-89
3286	59.5	30-Jun-89
3286	54.25	28-Jul-89
3286	53.6	30-Aug-89
3286	53.5	12-Sep-89
3286	54.65	14-Nov-89
3286	54.14	17-Jan-90
3286	53.16	12-Mar-90
3286	55.51	25-Apr-90
3286	65.51	10-Jul-90
3286	53.93	31-Aug-90
3286	58.42	02-Oct-90
3286	55.1	23-Oct-90
3286	54.3	04-Jan-91
3286	53.03	25-Apr-91
3286	57.55	30-May-91
3286	59.06	03-Jul-91
3286	54.71	06-Aug-91
3286	55.43	01-Oct-91
3286	54.9	14-Oct-91
3286	54.12	08-Jan-92
3286	53.43	03-Mar-92
3286	59.09	02-Apr-92
3286	53.12	21-Jun-92
3386	-1	12-Sep-86
3386	-1	13-Oct-86
3386	-1	26-Nov-86
3386	-1	01-Jan-87
3386	-1	25-Feb-87
3386	-1	24-Mar-87
3386	-1	08-May-87
3386	-1	03-Jun-87
3386	-1	08-Jul-87
3386	-1	04-Aug-87
3386	-1	03-Sep-87
3386	-1	24-Sep-87
3386	-1	21-Oct-87
3386	-1	09-Nov-87
3386	-1	01-Dec-87

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
3386	-1	21-Dec-87
3386	-1	11-Jan-88
3386	-1	29-Feb-88
3386	-1	21-Mar-88
3386	-1	18-Apr-88
3386	-1	15-Jun-88
3386	8.5	15-Jul-88
3386	-1	18-Aug-88
3386	-1	15-Sep-88
3386	-1	22-Oct-88
3386	-1	15-Nov-88
3386	-1	15-Dec-88
3386	-1	15-Jan-89
3386	-1	24-Feb-89
3386	-1	31-Mar-89
3386	-1	27-Apr-89
3386	-1	25-May-89
3386	-1	30-Jun-89
3386	-1	28-Jul-89
3386	-1	30-Aug-89
3386	-1	12-Sep-89
3386	-1	16-Nov-89
3386	-1	17-Jan-90
3386	6.64	24-Apr-90
3386	7.08	17-May-90
3386	8.29	11-Jul-90
3386 DRY		03-Aug-90
3386 DRY		01-Oct-90
3386 DRY		07-Nov-90
3386 DRY		04-Jan-91
3386 DRY		04-Jan-91
3386	6.15	11-Jun-91
3386	8.1	03-Jul-91
3386 DRY		05-Aug-91
3386	9.2	01-Oct-91
3386 DRY		01-Oct-91
3386 DRY		05-Mar-92
3386	5.97	02-Apr-92

Well No.	Depth from T.O.C.	DATE
3787	6.9	12-Nov-87
3787	6.6	22-Dec-87
3787	6.8	27-Jan-88
3787	6.3	29-Feb-88
3787	7	21-Mar-88
3787	6.6	18-Apr-88
3787	7	17-May-88
3787	6.7	15-Jun-88
3787	9.3	15-Jun-88
3787	6.5	15-Jul-88
3787	6.7	18-Aug-88
3787	7	15-Sep-88
3787	7.5	22-Oct-88
3787	8.4	15-Nov-88
3787	8.6	15-Dec-88
3787	8.8	15-Jan-89
3787	7.8	24-Feb-89
3787	7.8	31-Mar-89
3787	6.9	27-Apr-89
3787	6.2	26-May-89
3787	6.5	30-Jun-89
3787	7.09	28-Jul-89
3787	7.1	30-Aug-89
3787	6.33	11-Sep-89
3787	8	20-Nov-89
3787	8.98	17-Jan-90
3787	6.21	05-Mar-90
3787	5.96	24-Apr-90
3787	6.08	02-May-90
3787	6.87	10-Jul-90
3787	7.4	10-Aug-90
3787	7.42	21-Aug-90
3787	7.72	05-Sep-90
3787	8.13	01-Oct-90
3787	8.5	16-Oct-90
3787	8.67	02-Nov-90
3787	9.3	04-Jan-91
3787	6.53	03-Jun-91

Well No.	Depth from T.O.C.	DATE
3787	6.53	04-Jun-91
3787	6.92	19-Jun-91
3787	7.2	03-Jul-91
3787	7.49	30-Jul-91
3787	8.59	02-Aug-91
3787	7.9	04-Sep-91
3787	8.74	01-Oct-91
3787	8.94	09-Oct-91
3787	9.44	01-Nov-91
3787	7.5	03-Dec-91
3787	8.01	07-Jan-92
3787	8.35	22-Jan-92
3787	8.43	06-Feb-92
3787	8.96	26-Feb-92
3787	9.15	02-Mar-92
3787	5.92	02-Apr-92
3887	8.3	12-Nov-87
3887	8.2	21-Dec-87
3887	-1	27-Jan-88
3887	-1	29-Feb-88
3887	-1	21-Mar-88
3887	-1	18-Apr-88
3887	-1	17-May-88
3887	9.7	15-Jul-88
3887	9.7	18-Aug-88
3887	9.4	15-Sep-88
3887	9.8	22-Oct-88
3887	10.4	15-Nov-88
3887	10.6	15-Dec-88
3887	10.6	15-Jan-89
3887	10.6	24-Feb-89
3887	10.6	31-Mar-89
3887	10.6	27-Apr-89
3887	9.3	26-May-89
3887	8.9	30-Jun-89
3887	9.46	28-Jul-89
3887	9.55	30-Aug-89
3887	9.65	11-Sep-89

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
3887	9.95	16-Nov-89
3887	10.8	17-Jan-90
3887	10.95	23-Feb-90
3887	8.72	24-Apr-90
3887	9.22	23-May-90
3887	9.67	10-Jul-90
3887	9.93	23-Aug-90
3887	10.34	04-Oct-90
3887	10.55	08-Nov-90
3887	10.8	04-Jan-91
3887	11.02	24-Apr-91
3887	9.18	04-Jun-91
3887	9.54	03-Jul-91
3887	10.02	30-Jul-91
3887	11.41	01-Oct-91
3887	11.78	10-Oct-91
3887	10.17	07-Jan-92
3887	10.4	21-Jan-92
3887	10.4	21-Jan-92
3887	8.47	03-Apr-92
3987BR	23.9	12-Nov-87
3987BR	23.6	22-Dec-87
3987BR	40.2	01-Feb-88
3987BR	46.6	29-Feb-88
3987BR	108.6	21-Mar-88
3987BR	86	18-Apr-88
3987BR	86.5	16-May-88
3987BR	101.6	15-Jun-88
3987BR	99.1	15-Jul-88
3987BR	86.8	18-Aug-88
3987BR	102.5	15-Sep-88
3987BR	95	22-Oct-88
3987BR	83.9	15-Nov-88
3987BR	109.8	15-Dec-88
3987BR	89.9	15-Jan-89
3987BR	83.2	24-Feb-89
3987BR	82	31-Mar-89
3987BR	91.6	27-Apr-89
3987BR	85.7	26-May-89
3987BR	94.3	30-Jun-89
3987BR	85.55	28-Jul-89
3987BR	78.9	30-Aug-89
3987BR	110.45	12-Sep-89
3987BR	82.37	20-Nov-89
3987BR	92.6	17-Jan-90
3987BR	91.6	30-Jan-90
4386	-1	10-Oct-86
4386	-1	13-Oct-86
4386	16.76	26-Nov-86
4386	18.33	01-Jan-87
4386	16.75	01-Feb-87
4386	15.42	11-Mar-87
4386	13.1	08-May-87
4386	14.87	02-Jun-87
4386	14.2	07-Jul-87
4386	16.1	27-Jul-87
4386	16.8	04-Aug-87
4386	16.5	01-Sep-87
4386	18	29-Sep-87
4386	18.3	03-Nov-87
4386	16.75	01-Dec-87
4386	-1	21-Dec-87
4386	-1	11-Jan-88
4386	17.1	29-Feb-88
4386	16.9	21-Mar-88
4386	16.2	18-Apr-88
4386	17	16-May-88
4386	17	15-Jun-88
4386	18.1	15-Jul-88
4386	18.2	18-Aug-88
4386	18.2	15-Sep-88
4386	-1	22-Oct-88
4386	-1	15-Nov-88
4386	-1	15-Dec-88
4386	-1	15-Jan-89
4386	18.4	14-Feb-89
4386	17.5	27-Mar-89
4386	17.5	27-Apr-89
4386	17.8	28-May-89
4386	16	30-Jun-89
4386	18.11	21-Jul-89
4386	17.47	30-Aug-89
4386	17.83	12-Sep-89
4386	-1	06-Dec-89
4386	-1	15-Jan-90
4386	13.45	12-Apr-90
4386	16.02	05-Jun-90
4386	17.92	10-Jul-90
4386	17.38	09-Aug-90
4386 DRY		13-Aug-90
4386	18.23	10-Sep-90
4386	18.19	01-Oct-90
4386	18.41	11-Oct-90
4386 DRY		06-Nov-90
4386	18.36	07-Dec-90
4386 DRY		02-Jan-91
4386 DRY		02-Jan-91
4386 DRY		02-Apr-91
4386	16.21	07-May-91
4386	13.85	11-Jun-91
4386	15.99	02-Jul-91
4386	17.25	06-Aug-91
4386	15.98	19-Aug-91
4386	17.35	04-Sep-91
4386	18.73	04-Oct-91
4386 DRY		04-Oct-91
4386 DRY		08-Nov-91
4386	15.75	03-Dec-91
4386	17.51	03-Jan-92
4386		03-Feb-92
4386 DRY		03-Mar-92
4386 DRY		05-Mar-92
4386	12.9	08-Apr-92
4486	5.8	10-Nov-86

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
4486	6.62	13-Nov-86
4486	8.5	01-Jan-87
4486	9.08	08-May-87
4486	6.89	02-Jun-87
4486	6.15	08-Jul-87
4486	8.7	04-Aug-87
4486	9.6	21-Aug-87
4486	9.1	01-Sep-87
4486	10.7	29-Sep-87
4486	11.6	02-Nov-87
4486	11.6	11-Nov-87
4486	12	21-Dec-87
4486	12	11-Jan-88
4486	6.7	29-Feb-88
4486	6.5	21-Mar-88
4486	6.2	18-Apr-88
4486	6.9	16-May-88
4486	7.3	15-Jun-88
4486	7.7	15-Jul-88
4486	8	18-Aug-88
4486	7.2	15-Sep-88
4486	11.8	22-Oct-88
4486	9.1	15-Nov-88
4486	14.5	15-Dec-88
4486	8.4	15-Jan-89
4486	6.8	17-Feb-89
4486	6.8	27-Mar-89
4486	6.8	27-Apr-89
4486	6.2	19-May-89
4486	6.4	29-Jun-89
4486	7.8	14-Jul-89
4486	7.87	25-Aug-89
4486	5.85	13-Sep-89
4486	13.87	06-Dec-89
4486	12.97	16-Jan-90
4486	5.6	23-Mar-90
4486	5.98	12-Apr-90
4486	7.72	14-Jun-90
4486	6.68	10-Jul-90
4486	6.91	15-Aug-90
4486	7.15	27-Aug-90
4486	7.64	14-Sep-90
4486	7.32	04-Oct-90
4486	7.33	05-Nov-90
4486	8.1	07-Dec-90
4486	8.22	11-Dec-90
4486	14.43	03-Jan-91
4486	7.61	18-Mar-91
4486	7.27	02-Apr-91
4486	5.69	06-May-91
4486	5.87	07-Jun-91
4486	6.67	20-Jun-91
4486	7.65	05-Jul-91
4486	6.1	08-Aug-91
4486	6.38	14-Aug-91
4486	7.87	03-Sep-91
4486	8.87	04-Oct-91
4486	8.51	04-Nov-91
4486	7.68	08-Nov-91
4486	6.44	07-Dec-91
4486	8.61	09-Jan-92
4486	8.23	03-Feb-92
4486	8.24	05-Feb-92
4486	6.8	05-Mar-92
4486	6.25	06-Apr-92
5687	6.7	29-Feb-88
5687	7.8	21-Mar-88
5687	6.7	18-Apr-88
5687	6.2	17-May-88
5687	6.4	15-Jun-88
5687	6.4	15-Jul-88
5687	6.5	18-Aug-88
5687	7.8	15-Sep-88
5687	7.7	22-Oct-88
5687	8.1	15-Nov-88
5687	8.2	15-Dec-88
5687	8.4	15-Jan-89
5687	7.8	24-Feb-89
5687	7.6	31-Mar-89
5687	7	27-Apr-89
5687	6.5	26-May-89
5687	6.4	30-Jun-89
5687	6.88	28-Jul-89
5687	6.41	30-Aug-89
5687	7.53	11-Sep-89
5687	8.2	20-Nov-89
5687	9.21	17-Jan-90
5687	9.1	15-Feb-90
5687	6.82	25-Apr-90
5687	6.72	10-May-90
5687	7.84	11-Jul-90
5687	7.49	31-Jul-90
5687	9.32	10-Aug-90
5687	8.11	05-Sep-90
5687	7.8	02-Oct-90
5687	8.01	22-Oct-90
5687	9.68	02-Nov-90
5687	8.98	04-Jan-91
5687	9.7	08-Jan-91
5687	7.52	29-May-91
5687	9.32	07-Jun-91
5687	7.46	03-Jul-91
5687	7.45	23-Jul-91
5687	9.39	02-Aug-91
5687	7.44	04-Sep-91
5687	7.94	01-Oct-91
5687	7.97	03-Oct-91
5687	9.23	04-Nov-91
5687	8.18	03-Dec-91
5687	8.24	07-Jan-92
5687	8.31	09-Jan-92
5687	9.23	06-Feb-92
5687	9.08	02-Mar-92
5687	7.08	02-Apr-92

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
5687	6.93	06-Apr-92
6186	10.5	12-Dec-86
6186	10.93	15-Dec-86
6186	10.13	01-Jan-87
6186	8.33	10-Mar-87
6186	9.04	08-May-87
6186	-1	03-Jun-87
6186	10.85	24-Jun-87
6186	9.8	08-Jul-87
6186	10.2	06-Aug-87
6186	9.3	25-Aug-87
6186	9.9	01-Sep-87
6186	9.1	28-Oct-87
6186	8.8	02-Nov-87
6186	9.1	21-Dec-87
6186	9.3	11-Jan-88
6186	10.82	04-Feb-88
6186	9.9	29-Feb-88
6186	9.9	21-Mar-88
6186	9.4	18-Apr-88
6186	10	16-May-88
6186	10.1	15-Jun-88
6186	8.5	15-Jul-88
6186	10.2	18-Aug-88
6186	10	15-Sep-88
6186	10.5	22-Oct-88
6186	10	15-Nov-88
6186	10.4	15-Dec-88
6186	10.4	15-Jan-89
6186	6.9	17-Feb-89
6186	9.9	27-Mar-89
6186	10.9	27-Apr-89
6186	8.5	19-May-89
6186	10	29-Jun-89
6186	10.18	21-Jul-89
6186	9.43	25-Aug-89
6186	9.05	14-Sep-89
6186	10.3	06-Dec-89
6186	10.35	18-Jan-90
6186	7.75	23-Mar-90
6186	9.14	26-Apr-90
6186	9.82	18-May-90
6186	9.78	11-Jul-90
6186	9.82	03-Aug-90
6186	9.89	15-Aug-90
6186	9.86	07-Sep-90
6186	9.84	03-Oct-90
6186	10.28	02-Nov-90
6186	10.37	13-Dec-90
6186	10.86	04-Jan-91
6186	9.98	12-Jun-91
6186	9.92	03-Jul-91
6186	9.53	05-Aug-91
6186	9.33	07-Aug-91
6186	10.2	05-Sep-91
6186	9.9	02-Oct-91
6186	10.3	17-Oct-91
6186	9.49	04-Nov-91
6186	9.32	03-Dec-91
6186	10.29	07-Jan-92
6186	9.75	21-Jan-92
6186	9.75	21-Jan-92
6186	10.27	06-Feb-92
6186	10.49	02-Mar-92
6186	8.88	06-Apr-92
P114789	10.66	15-Jan-90
P114789	8.13	25-Apr-90
P114789	9	12-Jul-90
P114789	9.6	09-Aug-90
P114789	9.59	10-Sep-90
P114789	9.87	03-Oct-90
P114789	9.52	05-Nov-90
P114789	10.3	04-Dec-90
P114789	11.51	03-Jan-91
P114789	10.23	02-Apr-91
P114789	8.61	01-May-91
P114789	7.87	07-Jun-91
P114789	9.48	02-Jul-91
P114789	7.64	08-Aug-91
P114789	9.63	04-Sep-91
P114789	9.67	04-Oct-91
P114789	9.13	04-Nov-91
P114789	7.86	02-Dec-91
P114789	9.44	02-Jan-92
P114789	9.3	03-Feb-92
P114789	10.01	02-Mar-92
P114789	7.35	01-Apr-92
P114889	10.04	19-Jan-90
P114889	7.33	25-Apr-90
P114889	5.78	11-Jul-90
P114889	5.6	09-Aug-90
P114889	5.62	10-Sep-90
P114889	5.71	03-Oct-90
P114889	6.35	05-Nov-90
P114889	6.98	04-Dec-90
P114889	7.53	03-Jan-91
P114889	7.35	02-Apr-91
P114889	6.83	01-May-91
P114889	5.84	11-Jun-91
P114889	5.44	02-Jul-91
P114889	5.18	08-Aug-91
P114889	5.22	04-Sep-91
P114889	5.57	04-Oct-91
P114889	6.13	04-Nov-91
P114889	6.56	02-Dec-91
P114889	6.93	02-Jan-92
P114889	7.17	03-Feb-92
P114889	7.04	02-Mar-92
P114889	6.62	01-Apr-92
P115489	11.97	15-Jan-90
P115489	9.47	12-Jul-90
P115489	9.7	09-Aug-90
P115489	10.23	11-Sep-90
P115489	10.87	04-Oct-90

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
P115489	11.22	05-Nov-90
P115489	11.54	05-Dec-90
P115489	13.46	03-Jan-91
P115489	12.51	02-Apr-91
P115489	10.46	02-May-91
P115489	8.9	11-Jun-91
P115489	10.74	08-Jul-91
P115489	9.57	08-Aug-91
P115489	10.21	04-Sep-91
P115489	11.56	04-Oct-91
P115489	11.58	05-Nov-91
P115489	10.07	02-Dec-91
P115489	11.11	03-Jan-92
P115489	10.97	03-Feb-92
P115489	11.87	02-Mar-92
P115489	8.47	01-Apr-92
P115589	7.73	09-Jan-90
P115589	8.34	15-Jan-90
P115589	5.63	12-Jul-90
P115589	6.39	09-Aug-90
P115589	6.86	11-Sep-90
P115589	7.4	04-Oct-90
P115589	7.3	05-Nov-90
P115589	7.94	05-Dec-90
P115589	10	03-Jan-91
P115589	9.01	02-Apr-91
P115589	5.76	02-May-91
P115589	4.55	11-Jun-91
P115589	6.82	05-Jul-91
P115589	4.82	08-Aug-91
P115589	7.33	04-Sep-91
P115589	7.84	04-Oct-91
P115589	6.7	04-Nov-91
P115589	4.77	02-Dec-91
P115589	7.11	03-Jan-92
P115589	7.25	03-Feb-92
P115589	8.6	02-Mar-92
P115589	4.35	01-Apr-92

Well No.	Depth from T.O.C.	DATE
P115689	8.7	15-Sep-89
P115689	12.55	15-Jan-90
P115689	9.37	12-Jul-90
P115689	10.26	10-Aug-90
P115689	10.79	10-Sep-90
P115689	11.56	04-Oct-90
P115689	11.53	05-Nov-90
P115689	12.2	04-Dec-90
P115689	14.21	03-Jan-91
P115689	13.29	02-Apr-91
P115689	9.81	02-May-91
P115689	7.61	11-Jun-91
P115689	10.35	05-Jul-91
P115689	8.85	08-Aug-91
P115689	11.49	04-Sep-91
P115689	12.82	04-Oct-91
P115689	12.35	04-Nov-91
P115689	9.42	04-Dec-91
P115689	11.57	09-Jan-92
P115689	11.18	03-Feb-92
P115689	12.36	02-Mar-92
P115689	7.53	01-Apr-92
P207389	6.66	11-Sep-89
P207389	7.14	21-Sep-89
P207389	7.83	17-Jan-90
P207389	5.94	14-Mar-90
P207389	6.65	26-Apr-90
P207389	6.83	05-Jun-90
P207389	6.97	11-Jul-90
P207389	7.54	21-Aug-90
P207389	8.49	17-Dec-90
P207389	8.85	04-Jan-91
P207389	8.15	25-Mar-91
P207389	6.65	30-May-91
P207389	7.36	03-Jul-91
P207389	7.16	06-Aug-91
P207389	6.81	02-Oct-91
P207389	6.81	23-Oct-91

Well No.	Depth from T.O.C.	DATE
P207389	6.99	08-Jan-92
P207389	6.68	03-Mar-92
P207389	6.48	03-Apr-92
P207489	7.28	11-Sep-89
P207489	7.13	20-Sep-89
P207489	7.63	17-Jan-90
P207489	6	14-Mar-90
P207489	6.66	26-Apr-90
P207489	6.94	01-Jun-90
P207489	7.29	11-Jul-90
P207489	7.6	10-Aug-90
P207489	7.63	14-Aug-90
P207489	7.99	05-Sep-90
P207489	7.85	02-Nov-90
P207489	8.28	17-Dec-90
P207489	8.86	04-Jan-91
P207489	8.07	30-Apr-91
P207489	6.68	30-May-91
P207489	6.68	30-May-91
P207489	7.58	03-Jul-91
P207489	7.56	06-Aug-91
P207489	7.15	04-Sep-91
P207489	7.02	02-Oct-91
P207489	8.73	23-Oct-91
P207489	7.17	04-Nov-91
P207489	6.73	03-Dec-91
P207489	7.17	08-Jan-92
P207489	6.72	06-Feb-92
P207489	6.76	03-Mar-92
P207489	6.3	03-Apr-92
P207589	24.67	11-Sep-89
P207589	24.87	21-Sep-89
P207589	25.74	17-Jan-90
P207589	23.42	05-Mar-90
P207589	25.96	24-Apr-90
P207589	25.83	03-May-90
P207589	25.76	10-Jul-90
P207589	25.66	19-Jul-90

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
P207589	25.49	01-Oct-90
P207589	26.77	17-Dec-90
P207589	26.5	04-Jan-91
P207589	25.57	25-Mar-91
P207589	25.85	10-Jun-91
P207589	26.59	03-Jul-91
P207589	26.23	24-Jul-91
P207589	25.78	01-Oct-91
P207589	25.62	15-Oct-91
P207589	25.58	07-Jan-92
P207589	25.38	28-Jan-92
P207589	25.77	03-Apr-92
P207689	7.71	17-Jul-89
P207689	7.57	11-Sep-89
P207689	7.11	14-Sep-89
P207689	8.49	17-Jan-90
P207689	8.35	31-Jan-90
P207689	6.82	24-Apr-90
P207689	6.94	30-Apr-90
P207689	7.68	10-Jul-90
P207689	8.18	01-Oct-90
P207689	8.42	15-Oct-90
P207689	8.74	04-Jan-91
P207689	8.69	25-Mar-91
P207689	7.52	31-May-91
P207689	7.82	03-Jul-91
P207689	8.06	02-Aug-91
P207689	8.69	01-Oct-91
P207689	8.94	09-Oct-91
P207689	8.24	07-Jan-92
P207689	8.18	15-Jan-92
P207689	6.85	02-Apr-92
P207789	29.45	11-Sep-89
P207789	29.41	14-Sep-89
P207789	28.64	17-Jan-90
P207789	28.53	01-Feb-90
P207789	29.34	24-Apr-90
P207789	29.2	08-May-90
P207789	29.53	10-Jul-90
P207789	29.04	21-Aug-90
P207789	29.47	01-Oct-90
P207789	28.58	11-Dec-90
P207789	29.94	04-Jan-91
P207789	29.14	24-Apr-91
P207789	29.91	05-Jun-91
P207789	30.17	03-Jul-91
P207789	29.63	05-Aug-91
P207789	29.58	01-Oct-91
P207789	29.46	09-Oct-91
P207789	29.15	07-Jan-92
P207789	29	21-Jan-92
P207789	29	21-Jan-92
P207789	29.36	02-Apr-92
P207889	5.12	11-Sep-89
P207889	4.95	15-Sep-89
P207889	7.17	17-Jan-90
P207889	7.22	01-Feb-90
P207889	4.75	01-May-90
P207889	4.75	02-May-90
P207889	5.74	10-Jul-90
P207889	5.94	19-Jul-90
P207889	6.79	01-Oct-90
P207889	6.88	10-Oct-90
P207889	7.32	04-Jan-91
P207889	8.66	25-Mar-91
P207889	5.32	10-Jun-91
P207889	6.87	03-Jul-91
P207889	6.09	24-Jul-91
P207889	7.43	01-Oct-91
P207889	7.57	08-Oct-91
P207889	6.19	07-Jan-92
P207889	6.25	21-Jan-92
P207889	6.25	21-Jan-92
P207889	4.25	02-Apr-92
P207889	4.74	07-Apr-92
P207989	17.12	11-Sep-89
P207989	16.94	14-Sep-89
P207989	17.08	17-Jan-90
P207989	16.46	01-Feb-90
P207989	18.45	01-May-90
P207989	18.45	02-May-90
P207989	18.19	10-Jul-90
P207989	15.59	28-Aug-90
P207989	20.49	01-Oct-90
P207989	16.35	12-Dec-90
P207989	21.78	04-Jan-91
P207989	17.65	25-Mar-91
P207989	18.88	05-Jun-91
P207989	21.35	03-Jul-91
P207989	19.86	24-Jul-91
P207989	18.5	01-Oct-91
P207989	18.14	08-Oct-91
P207989	17.51	07-Jan-92
P207989	15.18	05-Mar-92
P207989	21.03	02-Apr-92
P207989	20.71	06-Apr-92
P208989	14.91	12-Sep-89
P208989	14.64	28-Sep-89
P208989	16.61	17-Jan-90
P208989	16.45	09-Mar-90
P208989	14.34	25-Apr-90
P208989	15.01	08-May-90
P208989	16.34	10-Jul-90
P208989	16.1	31-Jul-90
P208989	16.63	02-Oct-90
P208989	16.75	16-Oct-90
P208989	17.05	04-Jan-91
P208989	17.37	25-Mar-91
P208989	14.74	30-May-91
P208989	15.54	03-Jul-91
P208989	16.27	08-Aug-91
P208989	17.02	01-Oct-91
P208989	17.1	09-Oct-91
P208989	16.92	08-Jan-92

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
P208989	17.05	29-Jan-92
P208989	12.16	02-Apr-92
P209089	25.03	12-Sep-89
P209089	24.79	26-Sep-89
P209089	24.95	17-Jan-90
P209089	27.04	24-Apr-90
P209089	26.62	08-May-90
P209089	26.35	10-Jul-90
P209089	25.57	31-Jul-90
P209089	25.83	01-Oct-90
P209089	25.25	15-Oct-90
P209089	25.02	04-Jan-91
P209089	22.55	25-Mar-91
P209089	25.63	12-Jun-91
P209089	27.76	03-Jul-91
P209089	26.54	01-Aug-91
P209089	25.82	07-Oct-91
P209089	28.2	23-Oct-91
P209089	25.23	07-Jan-92
P209089	23	18-Mar-92
P209089	28.03	03-Apr-92
P209189	7.71	12-Sep-89
P209189	10.5	27-Sep-89
P209189	14.18	17-Jan-90
P209189	10.16	25-Apr-90
P209189	10.32	01-Jun-90
P209189	10.9	10-Jul-90
P209189	10.74	31-Aug-90
P209189	10.81	02-Oct-90
P209189	10.7	08-Nov-90
P209189	14.35	04-Jan-91
P209189	14.33	22-Mar-91
P209189	10.26	05-Jun-91
P209189	11.38	03-Jul-91
P209189	11.1	24-Jul-91
P209189	12.81	01-Oct-91
P209189	13.24	09-Oct-91
P209189	13.32	07-Jan-92

Well No.	Depth from T.O.C.	DATE
P209189	14.62	02-Mar-92
P209189	10.18	02-Apr-92
P209289	14.67	12-Sep-89
P209289	-1	25-Sep-89
P209289	-1	17-Jan-90
P209289	14.66	25-Apr-90
P209289	14.68	30-May-90
P209289	DRY	11-Jul-90
P209289	14.65	13-Aug-90
P209289	14.65	15-Aug-90
P209289	14.38	05-Sep-90
P209289	14.24	02-Oct-90
P209289	DRY	24-Oct-90
P209289	14.66	02-Nov-90
P209289	14.69	04-Jan-91
P209289	14.71	25-Mar-91
P209289	14.1	29-May-91
P209289	15.43	29-May-91
P209289	14.68	03-Jul-91
P209289	14.69	23-Jul-91
P209289	DRY	02-Aug-91
P209289	14.67	04-Sep-91
P209289	14.64	01-Oct-91
P209289	14.66	03-Oct-91
P209289	14.46	04-Nov-91
P209289	14.24	03-Dec-91
P209289	14.69	07-Jan-92
P209289	14.71	13-Jan-92
P209289	DRY	15-Jan-92
P209289	DRY	06-Feb-92
P209289	14.67	26-Feb-92
P209289	DRY	02-Mar-92
P209289	13.73	02-Apr-92
P209389	17.62	12-Sep-89
P209389	17.16	18-Sep-89
P209389	19.56	17-Jan-90
P209389	16.25	16-Mar-90
P209389	17.98	25-Apr-90

Well No.	Depth from T.O.C.	DATE
P209389	20.88	31-May-90
P209389	18.5	11-Jul-90
P209389	17.54	23-Aug-90
P209389	17.31	02-Oct-90
P209389	18.64	25-Oct-90
P209389	19.9	04-Jan-91
P209389	19.55	25-Mar-91
P209389	17.56	30-May-91
P209389	19.23	03-Jul-91
P209389	19.65	23-Jul-91
P209389	19.4	01-Oct-91
P209389	18.69	07-Oct-91
P209389	19.15	07-Jan-92
P209389	19.46	22-Jan-92
P209389	18.91	26-Feb-92
P209389	17.15	02-Apr-92
P209489	28.53	12-Sep-89
P209489	28.55	20-Sep-89
P209489	-1	17-Jan-90
P209489	27.87	25-Apr-90
P209489	28.52	31-May-90
P209489	28.68	10-Jul-90
P209489	28.58	15-Aug-90
P209489	28.65	02-Oct-90
P209489	28.88	25-Oct-90
P209489	29.35	04-Jan-91
P209489	29.95	25-Mar-91
P209489	28.58	03-Jul-91
P209489	29.58	01-Aug-91
P209489	29.01	01-Oct-91
P209489	29.32	15-Oct-91
P209489	29.41	07-Jan-92
P209489	29.6	29-Jan-92
P209489	26.5	02-Apr-92
P209589	16.68	12-Sep-89
P209589	16.59	19-Sep-89
P209589	17.99	17-Jan-90
P209589	17.62	30-Jan-90

Table 1.7
Water Level Measurements
of Wells In and Near OU8

Well No.	Depth from T.O.C.	DATE
P209589	17.9	25-Apr-90
P209589	16.55	24-May-90
P209589	19.02	10-Jul-90
P209589	20.78	28-Aug-90
P209589	19.79	02-Oct-90
P209589	18.49	06-Nov-90
P209589	19.27	04-Jan-91
P209589	17.58	25-Mar-91
P209589	18.74	05-Jun-91
P209589	19.99	03-Jul-91
P209589	18.7	31-Jul-91
P209589	18.73	01-Oct-91
P209589	18.78	03-Oct-91
P209589	18.63	07-Jan-92
P209589	18.54	09-Jan-92
P209589	18.36	02-Apr-92
P209689	26.47	13-Sep-89
P209689	28.19	17-Jan-90
P209689	27.6	15-Mar-90
P209689	29.11	25-Apr-90
P209689	28.99	30-Apr-90
P209689	28.63	10-Jul-90
P209689	28.49	19-Jul-90
P209689	28.41	01-Oct-90
P209689	28.4	02-Oct-90
P209689	28.3	10-Oct-90
P209689	28.02	04-Jan-91
P209689	28	07-Jan-91
P209689	28.44	25-Mar-91
P209689	28.98	04-Jun-91
P209689	27.15	12-Jun-91
P209689	29.28	03-Jul-91
P209689	28.81	31-Jul-91
P209689	28.58	01-Oct-91
P209689	28.19	07-Jan-92
P209689	28.02	21-Jan-92
P209689	28.02	21-Jan-92
P209689	28.45	02-Apr-92

Well No.	Depth from T.O.C.	DATE
P209789	5.18	13-Sep-89
P209789	8.82	17-Jan-90
P209789	3.34	15-Mar-90
P209789	5.07	25-Apr-90
P209789	5.53	04-May-90
P209789	7.11	10-Jul-90
P209789	6.65	24-Jul-90
P209789	8.42	01-Oct-90
P209789	8.85	19-Oct-90
P209789	9.92	04-Jan-91
P209789	10.36	22-Mar-91
P209789	6.59	07-Jun-91
P209789	7.42	03-Jul-91
P209789	7.59	01-Aug-91
P209789	9	01-Oct-91
P209789	9.41	11-Oct-91
P209789	8.42	07-Jan-92
P209789	8.89	20-Jan-92
P209789	8.89	20-Jan-92
P209789	4.7	02-Apr-92
P209889	4.68	12-Sep-89
P209889	5.22	26-Sep-89
P209889	5.15	17-Jan-90
P209889	4.52	09-Mar-90
P209889	4.43	25-Apr-90
P209889	4.5	23-May-90
P209889	5.06	10-Jul-90
P209889	5	22-Aug-90
P209889	4.98	02-Oct-90
P209889	5.15	29-Oct-90
P209889	5.46	04-Jan-91
P209889	5.02	25-Mar-91
P209889	4	04-Jun-91
P209889	4.51	03-Jul-91
P209889	4.47	06-Aug-91
P209889	5.25	01-Oct-91
P209889	5.34	14-Oct-91
P209889	5.01	07-Jan-92

Well No.	Depth from T.O.C.	DATE
P209889	5.21	22-Jan-92
P209889	5.3	27-Feb-92
P209889	4.49	02-Apr-92
P209989	-1	31-Aug-89
P209989	-1	11-Sep-89
P209989	-1	17-Jan-90
P209989	DRY	11-Apr-90
P209989	DRY	11-May-90
P209989	DRY	10-Jul-90
P209989	DRY	24-Jul-90
P209989	DRY	07-Aug-90
P209989	DRY	11-Sep-90
P209989	DRY	03-Oct-90
P209989	DRY	10-Oct-90
P209989	DRY	07-Nov-90
P209989	DRY	06-Dec-90
P209989	DRY	01-Apr-91
P209989	DRY	06-May-91
P209989	10.32	07-Jun-91
P209989	10.69	02-Jul-91
P209989	10.72	08-Jul-91
P209989	DRY	07-Aug-91
P209989	DRY	05-Sep-91
P209989	11.89	01-Oct-91
P209989	DRY	01-Oct-91
P209989	DRY	05-Nov-91
P209989	DRY	04-Dec-91
P209989	DRY	03-Jan-92
P209989	DRY	03-Feb-92
P209989	DRY	03-Mar-92
P209989	10.29	02-Apr-92
P210089	18.38	05-Sep-89
P210089	23.79	12-Sep-89
P210089	18.69	17-Jan-90
P210089	18.83	27-Feb-90
P210089	18.83	27-Feb-90
P210089	20.8	11-Apr-90
P210089	18.72	05-Jun-90

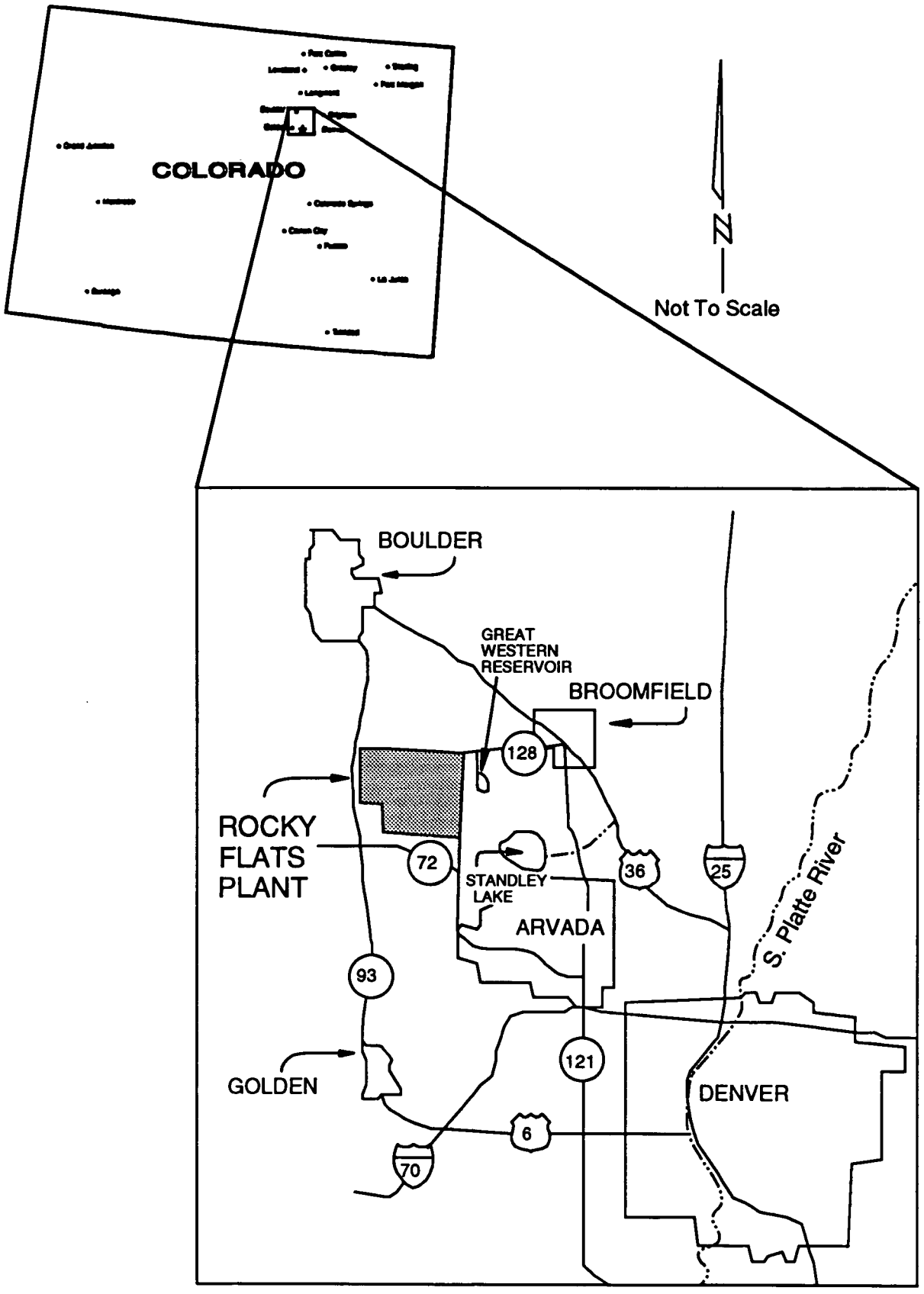


FIGURE 1-1
SITE LOCATION MAP - ROCKY FLATS PLANT

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

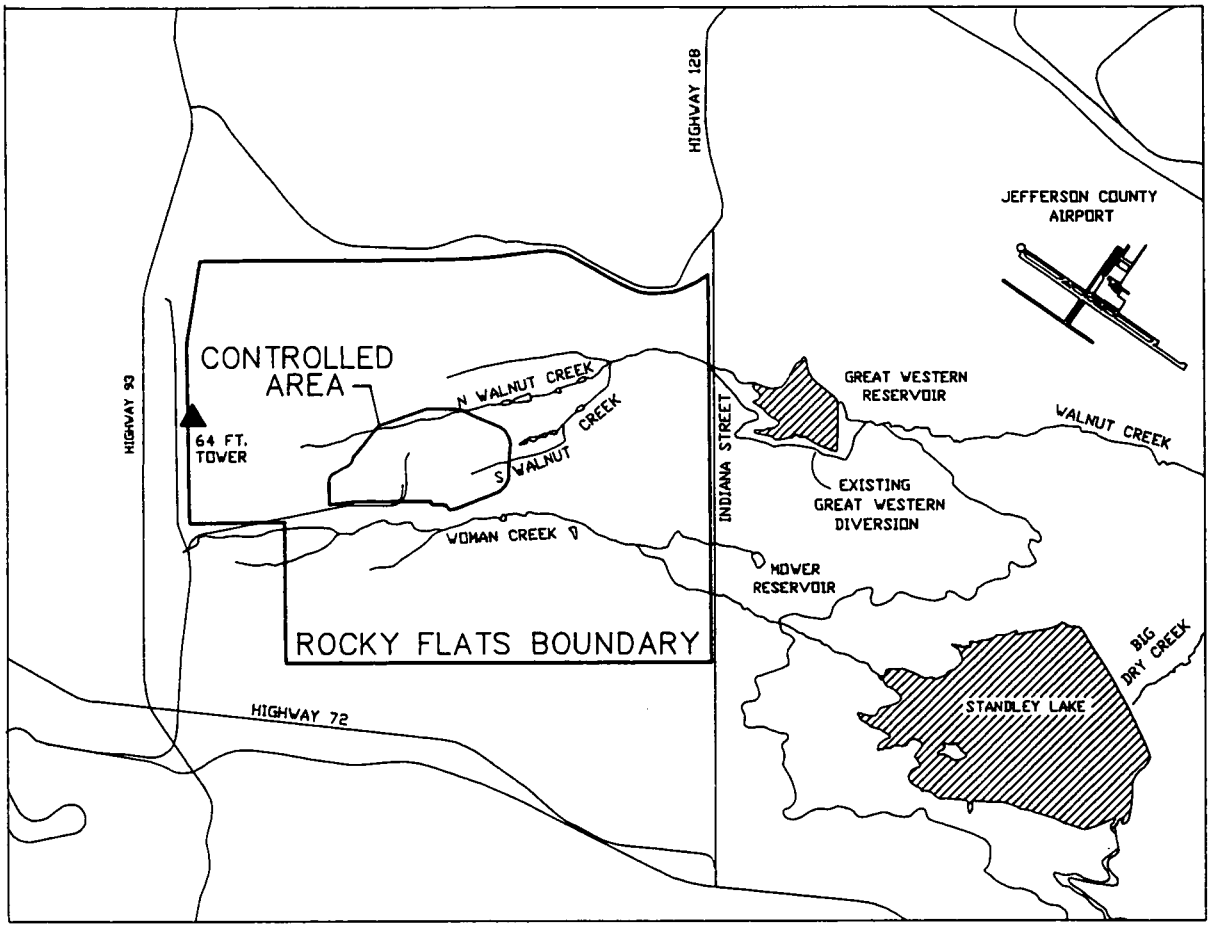
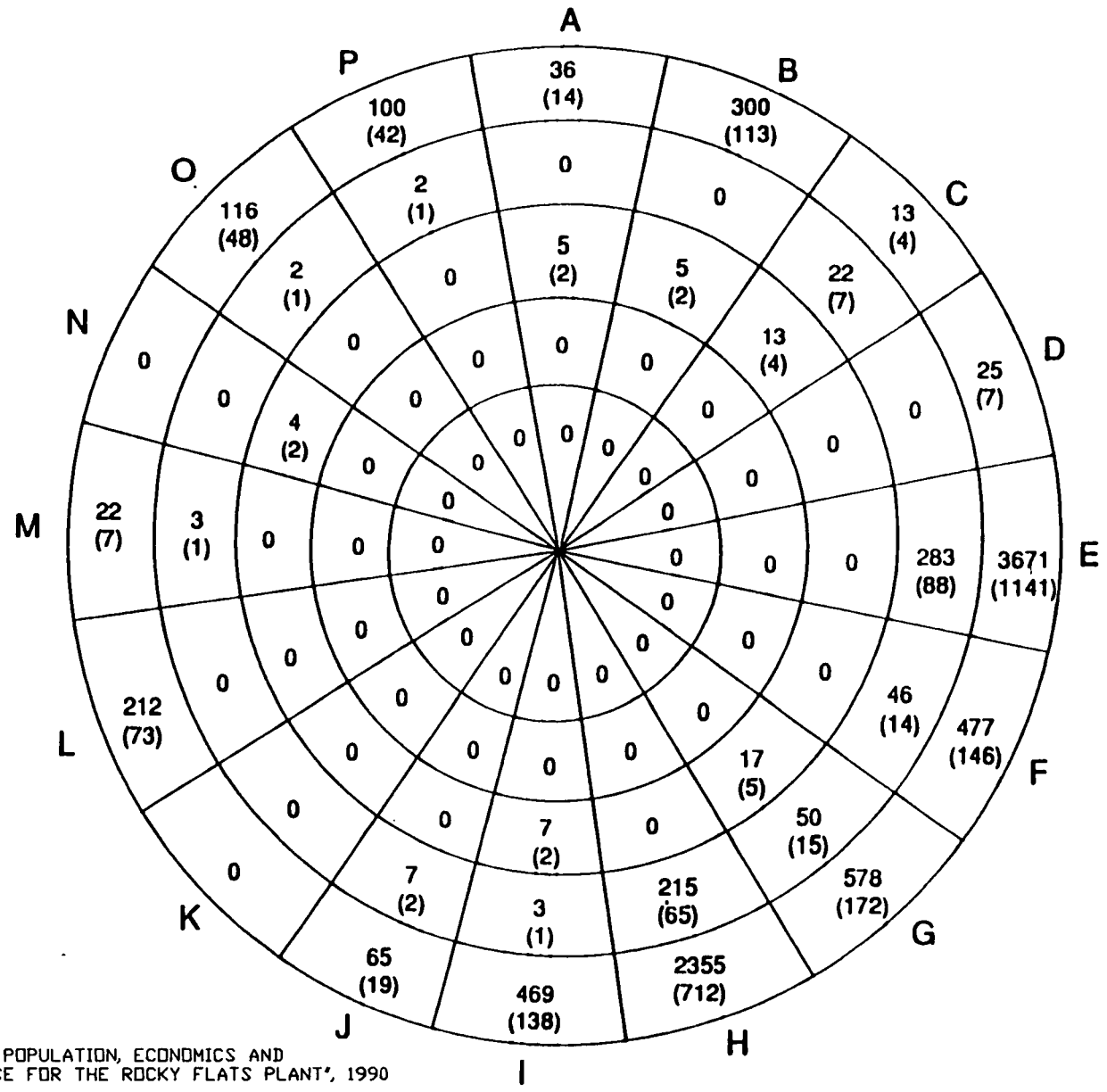


FIGURE 1-2
ROCKY FLATS PLANT

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

SOURCE: DOE, "1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT", 1990

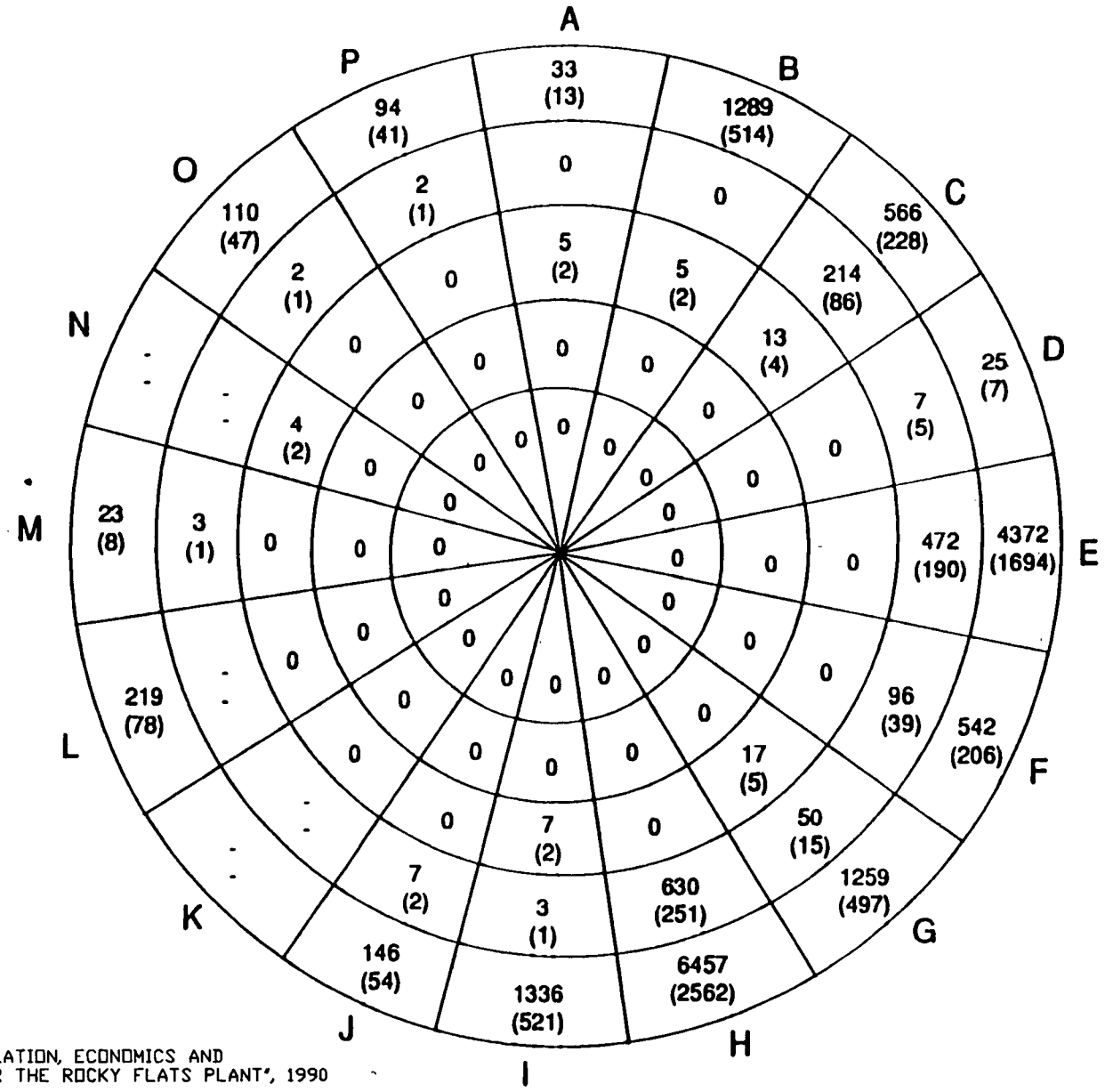
NOT TO SCALE

FIGURE 1-4

1989 POPULATION DISTRIBUTION, WITHIN 5 MILES OF THE ROCKY FLATS PLANT SITE

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

SOURCE: DOE, "1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT", 1990

-N-

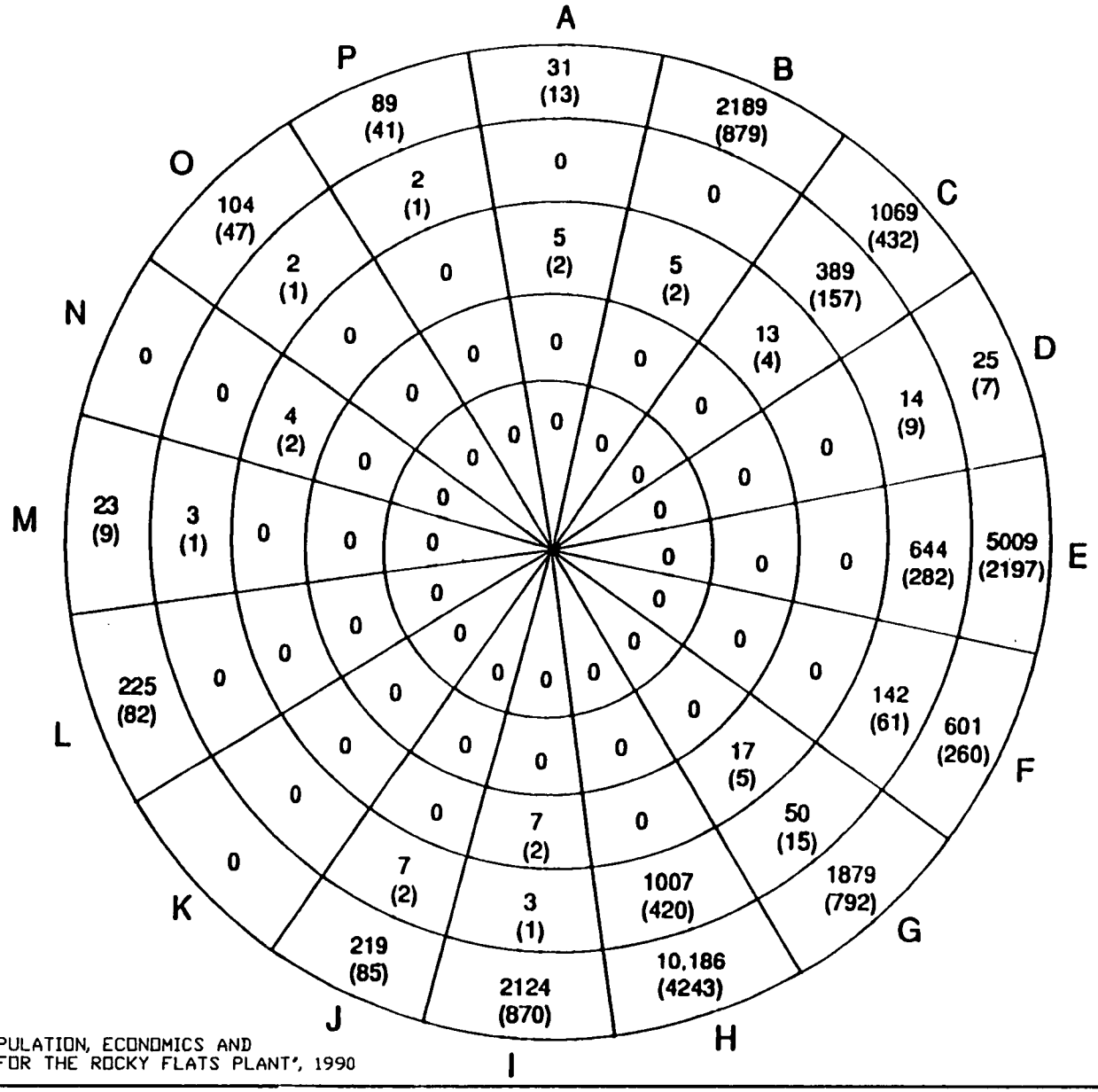
NOT TO SCALE

FIGURE 1-5

EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND THE ROCKY FLATS PLANT IN THE YEAR 2000

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

NOT TO SCALE

FIGURE 1-6

EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND THE ROCKY FLATS PLANT IN THE YEAR 2010

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

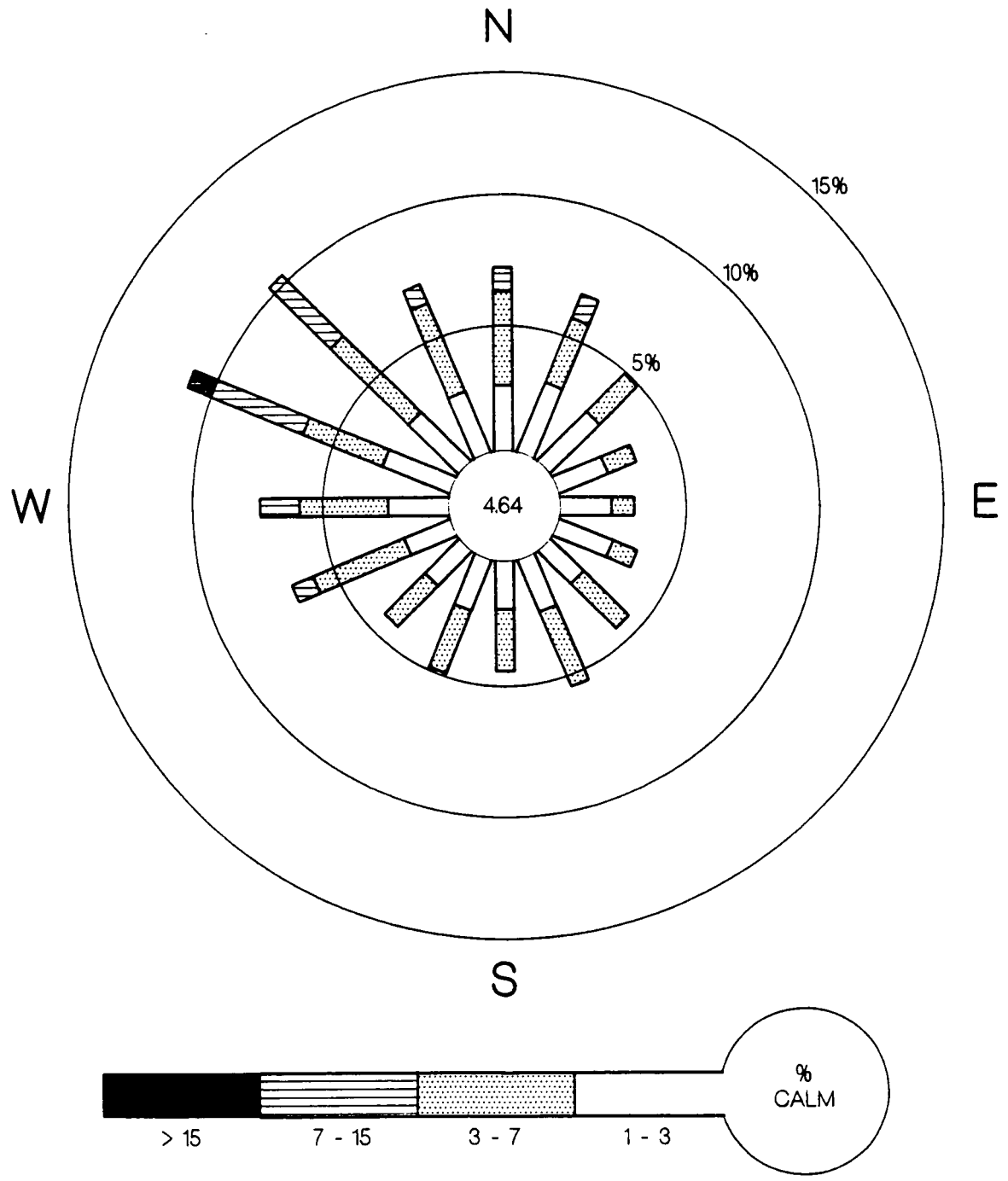
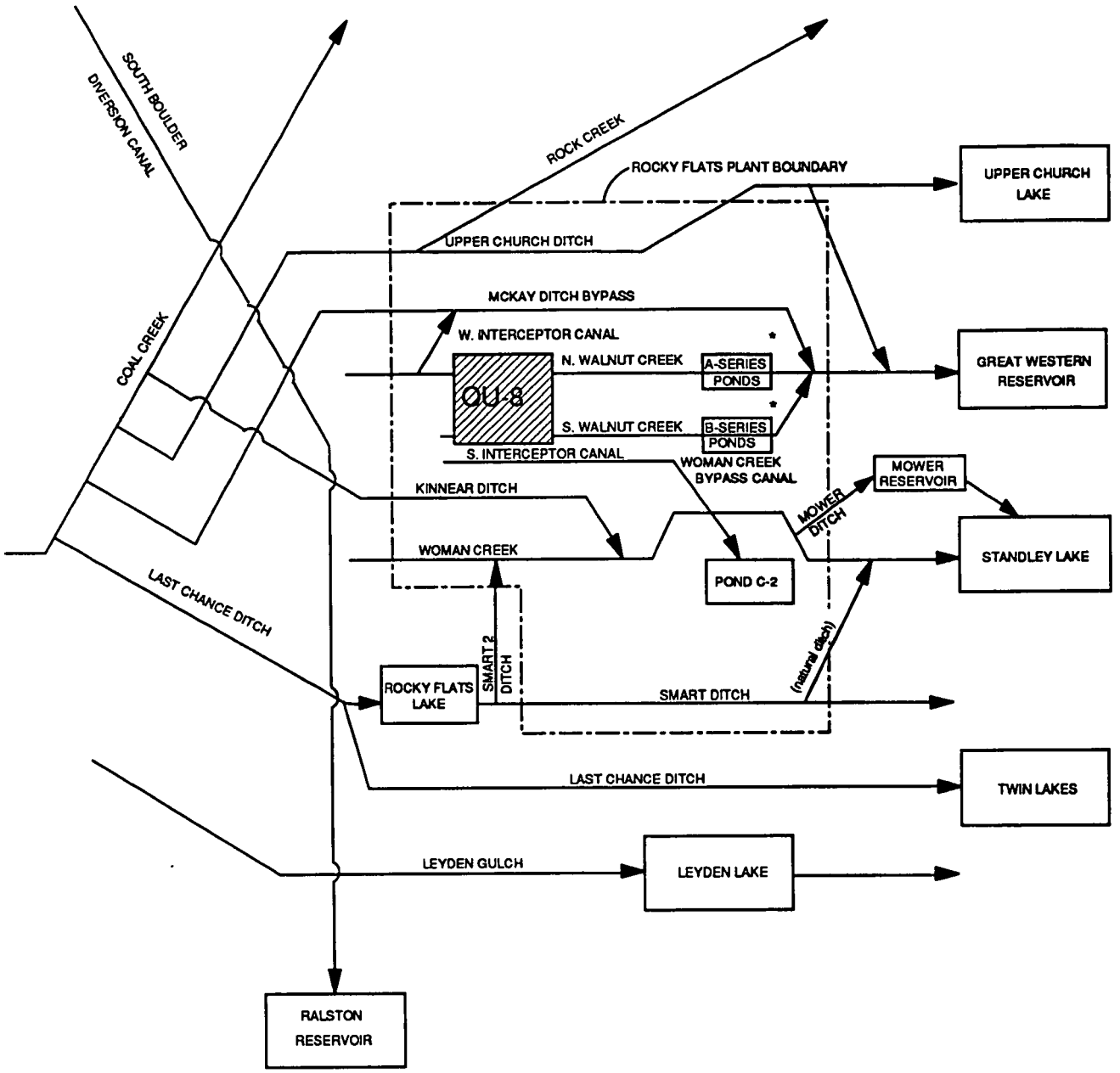


FIGURE 1-7
WIND ROSE FOR THE
ROCKY FLATS PLANT, 1990

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado



-N-

* See Figure 1-11 for details.

Adapted from HURR (1976)

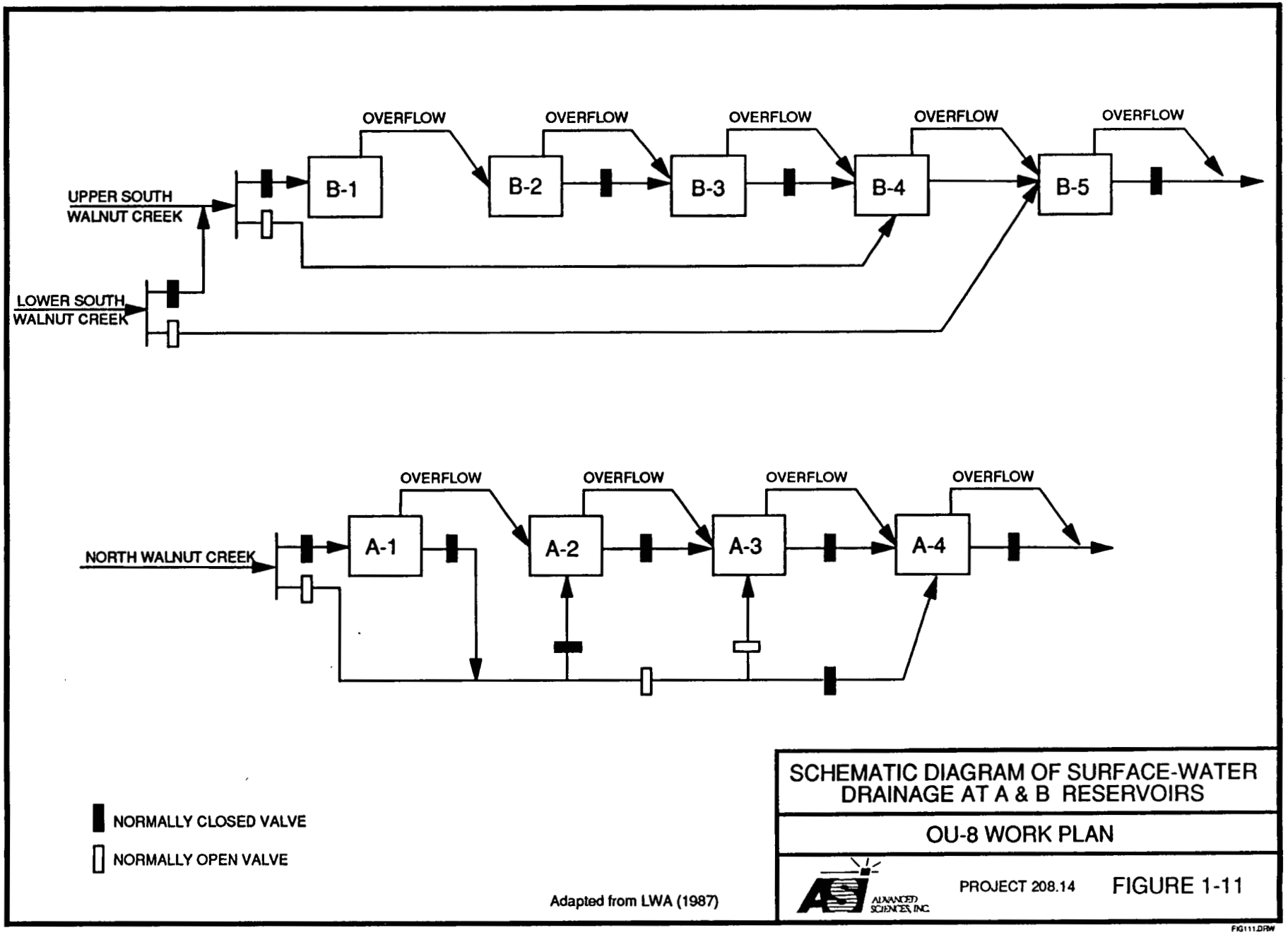
SCHEMATIC DIAGRAM OF SURFACE-WATER SYSTEM

OU-8 WORK PLAN

ADVANCED SCIENCES, INC.

PROJECT 208.14 FIGURE 1-10

FIG116.DRW



Adapted from LWA (1987)

SCHEMATIC DIAGRAM OF SURFACE-WATER DRAINAGE AT A & B RESERVOIRS

OU-8 WORK PLAN

ADVANCED SCIENCES, INC.

PROJECT 208.14

FIGURE 1-11

FIG111.DRW

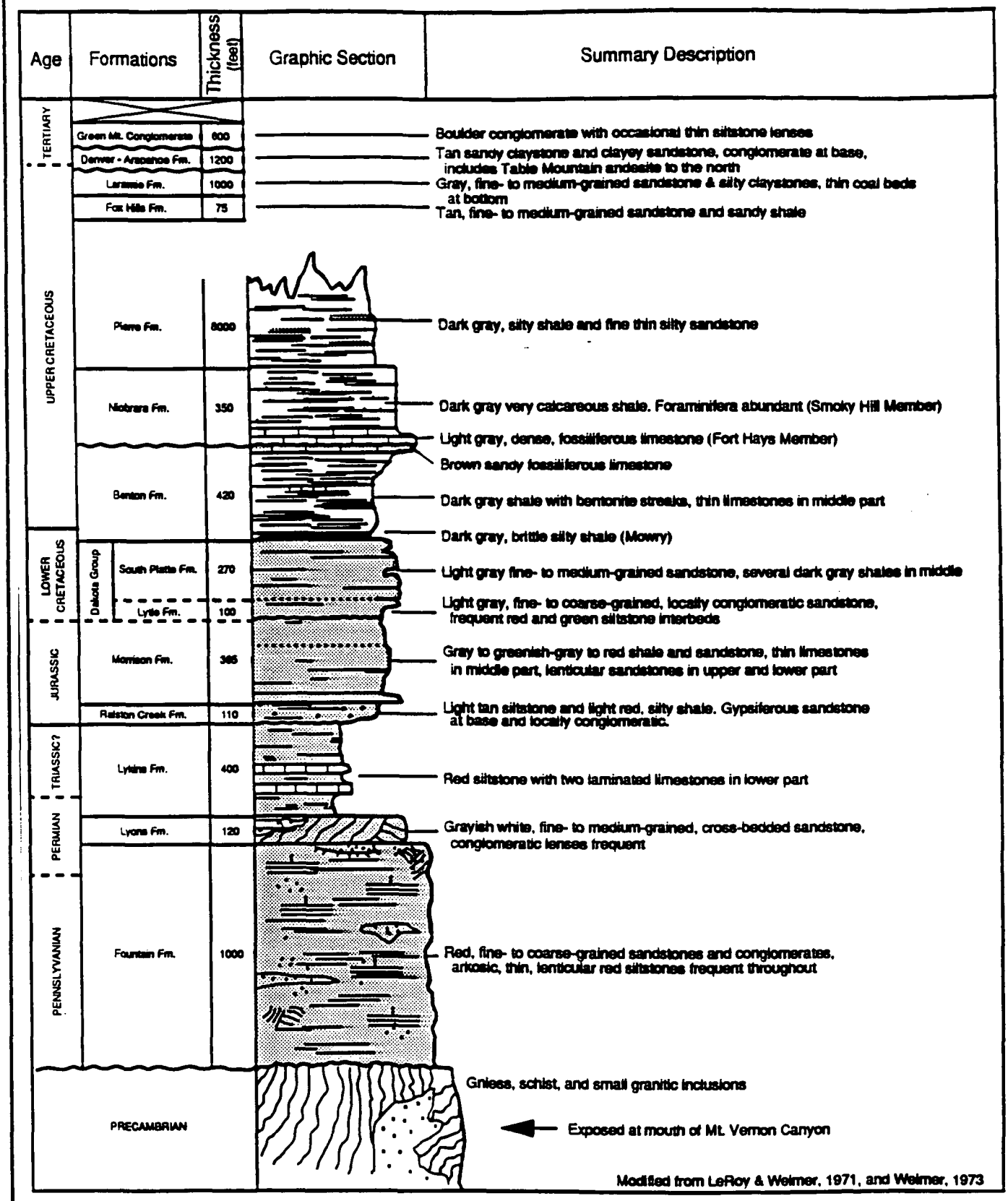


FIGURE 1-16
GENERALIZED STRATIGRAPHIC SECTION, GOLDEN - MORRISON AREA

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

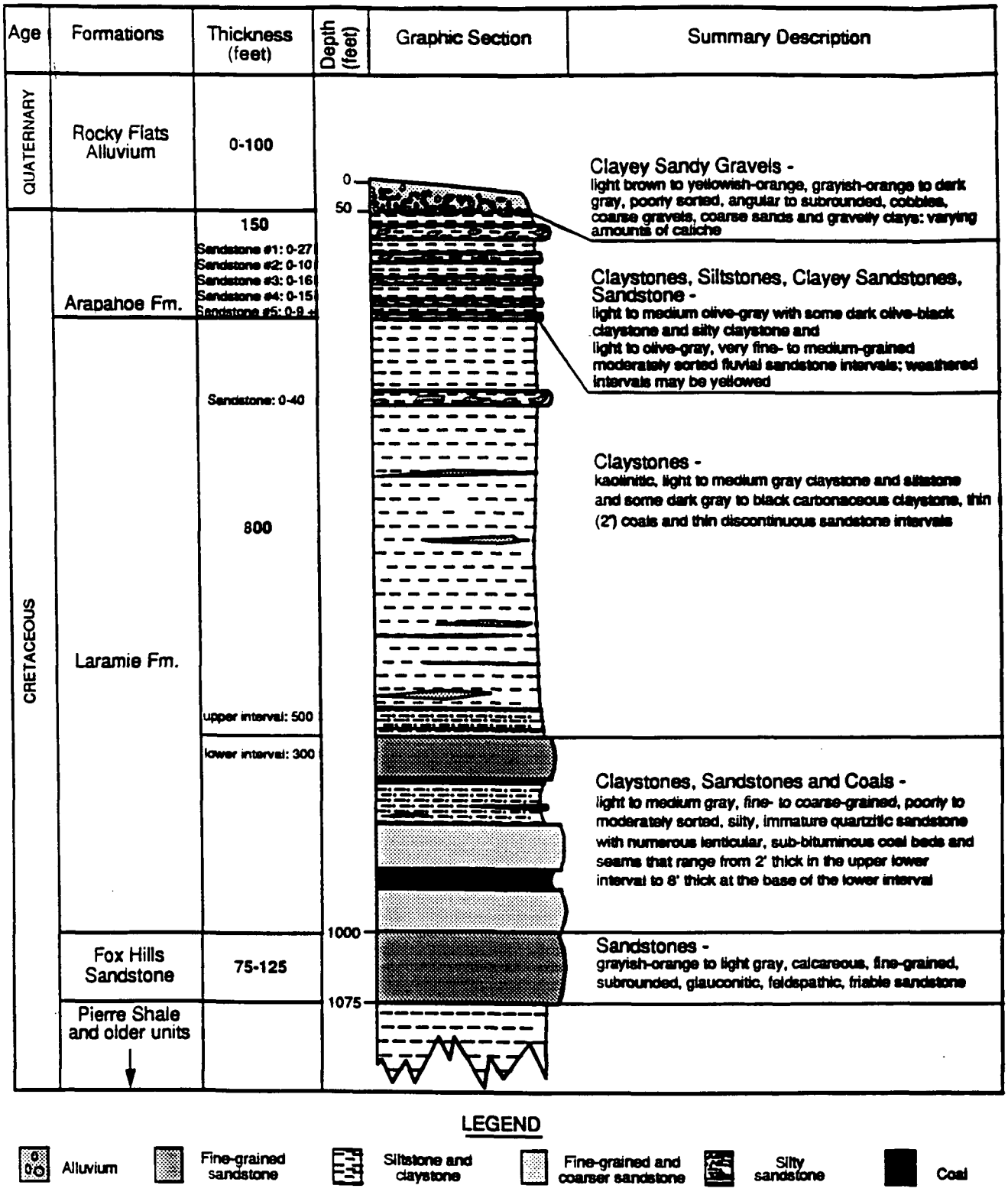


FIGURE 1-17
GENERALIZED STRATIGRAPHIC SECTION, ROCKY FLATS PLANT

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

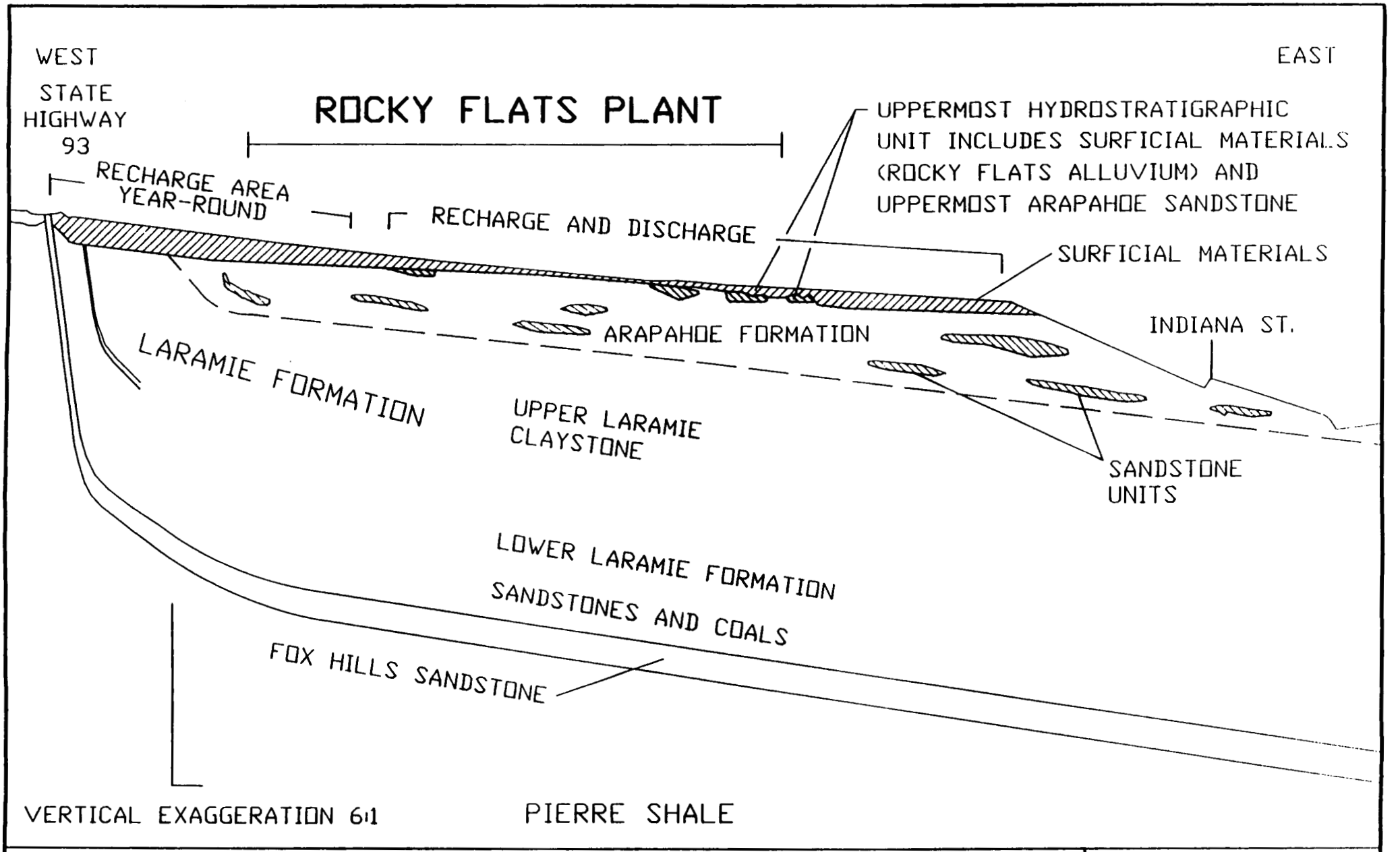


FIGURE 1-18
SCHEMATIC WEST TO EAST STRUCTURAL CROSS SECTION

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

2.0 OPERABLE UNIT 8 SITE CHARACTERIZATION

Information presented in the following discussion of IHSSs is taken from descriptions presented in the Historical Release Report (DOE, 1992) for the RFP, engineering designs drawings, and facilities drawings. For several IHSSs, this information was recently updated by Doty & Associates, Boulder, Colorado, as part of a subtask to preparing this Work Plan. This research has been included in the IHSS descriptions provided below. This research includes additional background information regarding release mechanisms, revisions to IHSS size and location, and the nature of operations and potential contaminants occurring at a given site.

2.1 PREVIOUS INVESTIGATIONS AT OU8

Due to its location within the RFP and its size, OU8 is adjacent to and/or overlain by several other OUs, including:

OU2 - 903 Pad, Mound and East Trenches
OU4 - Solar Ponds
OU6 - Walnut Creek Drainage
OU9 - Original Process Waste Lines
OU10 - Other Outside Closures
OU12 - 400/800 Area Sites
OU13 - 100 Area
OU14 - Radioactive Sites
OU15 - Inside Building Closures and,
OU16 - Low Priority Sites.

Several of these OUs are either currently undergoing studies or have had studies completed recently that are likely to provide data supporting the determination of the nature and extent of contamination at OU8. The OU2 RFI/RI Work Plan has been provisionally accepted by regulatory agencies for implementation.

In addition, several investigations and studies have been undertaken at OU8, in response to spills and other incidents related to the individual IHSSs. These investigations and studies include the following:

"774 Spill-Tank 66 Analytical Report," L.P. Johnson, 1981, EG&G Internal Report.

"776 Utilities Compressor House Oil Spill," R.E. Smith, 1986, EG&G Internal Report.

"Building 559 Groundwater Contamination," M.V. Werkema, 1977, EG&G Internal Report.

CEARP Phase I, Effluent Pipe, 700 Area.

"Decontamination of Building 76 and Environs Following Incident of June 12, 1964," J.B. Owen, 1964.

"Disposition of South Section of Clay Lined Pond in Relation to Proposed Building 79," E.S. Ryan, 1962.

"Engineering and Geologic Investigation for Two Additions to Building No. 774, AEC Rocky Flats Facility," Woodward-Clevenger & Associates, 1970.

Evaporation Ponds, A.H. Voight, 1971.

"Final SIR 87-6-774.1 Caustic Spill," D.O. Kissell and F.P. McMenus, 1987.

"Fire--Building 71, September 11, 1957," J.B. Owen, 1957.

"History of 207 Solar Evaporation Ponds and Nitrate in Walnut Creek," J.B. Owen, 1974.

"Investigation of Radioactivity Found in 701 Building Sanitary Sewer Backflow and in 995 Building Outfall, June 7-13, 1972," Werkema, 1972.

"Oil Spill Documentation," M.L. Paricio, 1986.

"RCRA Closure Plan Tanks T-40, T-66, T-67, T-68 Hazardous Waste Management Unit 55 for USDOE - Rocky Flats Plant Transuranic Mixed Waste," Rockwell International, 1989.

"Report of Investigation on a Recent Process Waste Pipeline Leak," C.T. Illsley, 1980.

"The Composition of Pond 2A," R.L. Delnay, 1959.

2.2 REGULATORY BACKGROUND AT OU8

The Phase I RFI/RI and all response activities performed by DOE under the IAG are planned so as to be consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), the Resource Conservation and Recovery Act (RCRA), the Colorado Hazardous Waste Act, and pertinent EPA guidance documents. However, the primary source of the scope of work for the OU8 Phase I RFI/RI is the IAG, which formulates a phased approach for investigation and remediation tailored to the particular requirements of RFP. According to the IAG, the Phase I RFI/RI will determine, for each IHSS, the source and extent of contamination in soil, sediments, surface water, groundwater and air, identify additional investigations work needed, and provide information for a Human Health Risk Assessment. If further characterization of contamination within the OU8 area is required involving groundwater (alluvium and Arapahoe Formation), surface water, and biota, it is anticipated these will be addressed in a Phase II RFI/RI.

2.3 CURRENT CONDITIONS AT IHSSs WITHIN OU8

The current conditions described in this subsection are based on historical reports, review of historical photographs, site visits, and interviews with former and present RFP employees.

2.3.1 IHSS 118.1 - Solvent Spills West End of Building 730

IHSS 118.1 has been defined as a 50- by 180-foot area between Buildings 776 and 701 (EG&G, 1990e). A 5,000-gallon underground steel carbon tetrachloride storage tank was located adjacent to the west side of Building 730, just north of Building 776. On June 18, 1981, the tank failed, releasing carbon tetrachloride into the sump. The tank was subsequently removed following this failure (EG&G, 1992).

Drawings, including D-13491A, D-13492A, and D-13493A, provide dimensions and details of the tank which may be of importance when planning the environmental investigation of the area.

The length of the tank (north/south) was approximately 14 feet, and the diameter was approximately 8 feet. The south end of the tank was enclosed in a concrete structure which provided maintenance access and encased the piping. The dimensions of the concrete structure were approximately 6 feet wide, 12 feet long, and 12 feet deep. The wall thickness was approximately 9 inches. An 18-inch square sump pit located in the southwestern corner at the bottom of the structure provided drainage. The bottom elevation of the interior of the structure was at 5,976 feet and the top of the structure was at 5,988 feet. The ground surface around the structure was approximately 1 foot below the top of the structure.

This structure encased only approximately 3 feet of the south end of the tank. The tank was supported by the concrete structure and a concrete footing approximately 3 feet wide located at the north end. It is unclear from the design drawings how deeply the north portion of the tank (that was not enclosed in the structure) was buried. The material which had surrounded the north portion of the tank is unknown.

The area is relatively flat and includes both paved and unpaved surfaces. Prior to 1968, the entire area was unpaved. The location is highly congested with overhead, ground-level, and underground pipes and utilities. The ground surface around the tank location was diked (EG&G, 1990c).

2.3.2 IHSS 118.2 - Solvent Spill South End of Building 776

IHSS 118.2 has been defined as a 30- by 70-foot area south of Building 776 (EG&G, 1990c). The area appears on the IHSS map to occupy part of the long, narrow alley between Buildings 707 and 778.

Available references state that IHSS 118.2 consists of organic solvent tanks located inside Building 776 at the south end, and a 5,000 gallon, above ground carbon tetrachloride tank located within a bermed area between the north side of Building 707 and the alleyway south of Building 778. Degreasing solvents which may have been stored in the organic solvent tanks include carbon tetrachloride, petroleum distillates, benzene and dichloromethane paint thinner, 1,1,1-trichloroethane (TCA) and methylethylketone (MEK). Solvent held in carbon tetrachloride tank is used in Buildings 776 and 707.

The surrounding area is flat and fully paved, and receives moderate traffic.

2.3.3 IHSS 123.1 - Valve Vault 7 Southwest of Building 707

IHSS 123.1 is defined as a 30- by 30-foot area southwest of building 708. More specifically, the area is centered around Valve Vault 7, immediately adjacent to the Protected Area (PA) between the Protected Area inner fence and the perimeter road (EG&G, 1990c).

Valve Vault 7 is part of the New Process Waste Line system and it controls the 800 Area main process waste line. This valve vault was constructed to replace the original vault (also designated Valve Vault 7), which was located west of Building 707 several hundred feet to the north. The original Valve Vault 7 was removed in March 1973; the location now constitutes IHSS 123.2 (EG&G, 1990c).

The transfer of liquid waste from the holding tanks at Building 881 was discontinued after a leak was identified. Temporary dikes were constructed to contain the overflow. A dam was constructed in the ditch east of the guard shack at Portal #1 and another dam was placed just west of Guard Shack 762. Drainage from the area was diverted to Pond B-1 (EG&G, 1992).

Accounts of the April 4, 1983 process wastewater spill indicate drainage is east from the system ditch near the Eighth Street and Sage Avenue toward South Walnut Creek and the B-Series

drainage ponds. Runoff was noticed flowing across the former 750 Parking Lot, through the Building 991 normal runoff drainage (EG&G, 1992).

The IHSS slopes gently to the east and includes both paved and unpaved surfaces. Access to the south of the area is restricted by the PA, while the perimeter road to the north is heavily travelled by RFP traffic. Overhead electric lines and underground process waste lines exist in the area. The valve vault presently is covered by a wood and polyethylene shelter (EG&G, 1990).

The Historical Release Record (HRR) states that IAG maps have mislocated this IHSS in the same area as the Original Process Waste Line (OPWL) valve vault several hundred feet to the north (EG&G, 1992). The HRR suggests that based on this information, the proposed boundaries defining this IHSS in the IAG be extended to include the storm runoff collection system ditch near Eighth Street and Sage Avenue and continue to the extent of Pond B-1 (EG&G, 1992).

2.3.4 IHSS 123.2 - Valve Vault West of Building 707

IHSS 123.2 has been defined as a 30- by 30-foot area on the west side of Building 707 (EG&G, 1990c). This IHSS is the original Valve Vault 7 that was removed in March 1973, as discussed in Section 2.3.3 above.

This IHSS consists of a valve vault on the original process waste lines (OPWLs). The OPWLs were installed at various times from 1952 until approximately the mid 1970's, and were taken out of service during a period from the mid-1970's to the mid-1980's. The OPWL were originally laid out just west of Building 881 to Building 774 consisting of a 3-inch diameter saran-lined pipe encased in a 10-inch diameter vitrified clay pipe (VCP). to a 45-degree elbow. At this elbow the line extended to the northeast at which point another 45-degree elbow re-directed the waste to a north-south ending at Building 774. Flow in this line was by gravity. The OPWL were typically abandoned in place (EG&G, 1992).

At some time after construction of the OPWL in this area a valve vault was installed at the location of the south 45-degree elbow (Doty & Associates, 1992 [Appendix B]). This is the valve vault referred to as "the valve vault west of 707." The diagonal line (from the south 45-degree elbow to the north 45-degree elbow) was abandoned in 1968 due to the construction of Building 707 over the line (Rockwell, 1976). The alignment of the OPWL was modified so that a 3-inch diameter stainless steel line ran due north. Another valve vault was built to allow for process waste collection from Building 559 which became operative in 1968 (Doty & Associates, 1992 [Appendix B]). This valve vault could also be described as "west of 707," but is further north than the one at which the 45-degree elbow had been located. The new PWL to the east and eventually to Building 774 (EG&G, 1990a).

The IHSS area is unpaved and open, slopes gently to the east, and is used only lightly for storage and traffic. Underground waste lines and other utilities exist in the vicinity (EG&G, 1990c). Because the OPWLs are sloped to allow for gravity drainage, the migration of waste along the backfill of the OPWL would probably have been from the south 45-degree elbow (N36,910, E20,560) to the north 45-degree elbow (N37,340, E20,990), a distance of approximately 630 feet. The approximate invert elevation of the OPWL at the south 45-degree elbow is 5,986.34 feet, while at the north 45-degree elbow the invert elevation is approximately 5,982.80. Based on current topography these inverts should be approximately 5.5 feet deep and approximately 3.2 feet deep, respectively. Approximately 360 feet of the diagonal OPWL pipe is either buried beneath Buildings 707 and 778, or has been removed for the construction of Buildings 707 and 778 (EG&G, 1990b). It is possible that the remainder of the diagonal pipe could have been removed during construction activities related to Building 707, but this is considered unlikely (Doty & Associates, 1992 [Appendix B]).

Surface water drainage in the vicinity of the north and south 45-degree elbows is currently to the east. The surface water drainage patterns at the south 45-degree elbow are expected to be the same as those at the time of the 1958 spill. However, the ditch near the north 45-degree elbow discussed in the description of the 1958 spill is assumed to have been associated with a road

noticeable in a 1955 aerial photograph of RFP. Based on the original contours of the land in this area, it is expected that flow in the ditch near the north 45-degree elbow would have been to the south. Ultimate drainage from each of these areas in 1958 was to South Walnut Creek.

It is probable that subsurface geotechnical investigations were conducted for Building 707 prior to its construction. Monitoring wells located in the general vicinity of this IHSS are 23-86, 24-86, and 180-89.

2.3.5 IHSS 125 - 14,000-Gallon Holding Tank (Tank #66)

IHSS 125 consists of Tank #66, a 14,000-gallon reinforced concrete tank (for high-nitrate treated waste), located southeast of the original Building 774 (EG&G, 1992). The tank is associated with Tank #67 located directly south of Tank #66 (they are of the same size, construction, and age and share an internal wall). Tank #68 is also similar to tank #66 and is located 2 feet south of Tank #67 and was built in 1958. Tanks #66, #67, and #68 are also identified in the IAG as IHSSs 124.2, 124.3, and 124.1, respectively, and are currently included in OU10. These tanks are also included in RCRA Unit 55 for which a closure plan was written in 1989 (Doty & Associates, 1992 [Appendix B]).

Tank #66 is an underground concrete process waste holding tank at the southeast corner of Building 774 and has a nominal capacity of 12,000 gallons. The tank was included in a 1953 engineering drawing but it is unclear when it was first placed into service. Liquid waste was transferred to or from the tank through pipes connected with the Building 774 treatment process. A manhole is located at the top of the tank. Four 3-inch diameter pipes enter Tank #66 from the north end of the west wall. Two inflow pipes enter 2 feet from the roof of the tank. One passes through Tank #66 and enters Tank #67. Two outlet pipes enter approximately 6 inches from the floor of the tank, and one passes through into Tank #67. The elevation of the outlet pipe above the floor of Tank #66 allows approximately 1,000 gallons of liquid to remain in the tank (Doty & Associates, 1992 [Appendix B]).

The walls of the tank are approximately 10 inches thick. The bottom elevation is approximately 5,955 feet and the tank is approximately 8 feet high. The area occupied by the tank is 21.5 feet (east-west) by 11 feet (north-south). The floor of tank was at the same approximate height as the second floor of Building 774 and a short pipe tunnel connects the building with the tank. Ground elevation to the east of the tank is approximately 5,962 feet (Doty & Associates, 1992 [Appendix B]). The west side of Tanks #66 and #67 are 4 feet from the east sides of the concrete storage tanks (IHSS 146). A shed was constructed over Tanks #66 and #67 with bay doors at the east and west sides. The roof of the tanks serves as the floor to the shed.

Approximately 4 feet of the north side of the tank was exposed above the ground surface in 1965 photographs. The ground sloped to the north approximately 25 feet to a loading dock on the east wall of Building 774. The ground elevation dropped approximately 12 feet in that distance (Doty & Associates, 1992 [Appendix B]). In photographs from 1969 and from the 1970 engineering report prior to the construction of an addition to the building, it is clear that an addition to the building was constructed in the area between the loading dock and the tank, and extended to the east beyond the east side of Tank #66.

Much of the soil surrounding the concrete tanks was disturbed during the construction of the addition (between 1965 and 1969) and paving of the area surrounding the tanks. Because of the steep slope in area, the bottom level of the tanks was near the level of the second floor of Building 774. Therefore, the soil beneath the tank is adjacent to the rooms on the first floor of the building (Doty & Associates, 1992 [Appendix B]).

The subsurface investigations prepared in 1962 and 1971 identified borehole lithology in the area of Building 774. Boring logs from the 1970 study indicate that the subsurface geology consists of sandy, clayey gravel, descending to sandy clay to claystone (Woodward-Clevenger, 1971). The surface geology south of the building has changed because of the construction of the addition and removal of contaminated soil. A number of wells are located to the north, south, and

especially the east of Building 774, primarily due to the presence of the RCRA-regulated solar ponds (Doty & Associates, 1992 [Appendix B]).

Surface drainage from the hillside south of the building is toward the north. A roadway is located on the top of the slope. A footing drain which daylights north of the building between the western condensate receiving tank (Tank T-108) and Building 770 originates south of the building near the concrete tanks.

Because Tank #66 is also discussed with Tanks #67 and #68 as IHSS 124, it has been proposed that IHSS 124 and IHSS 125 be redefined as a single IHSS encompassing Tanks #66, #67, and #68 (EG&G, 1990).

2.3.6 IHSS 126.1 and 126.2 - Out-of-Service Process Waste Tanks (Building 728)

IHSS 126 has been defined as a 50- by 50-foot area at the northwest corner of Building 771. More specifically, it is centered around Building 728, immediately north of Building 771 (EG&G, 1990c). The area is paved and slopes slightly to the north (EG&G, 1990c).

This unit is part of the OPWL system. The IHSS consists of two 20,000- to 25,000-gallon capacity, below-grade, concrete waste tanks housed in Building 728. The tanks were built in 1952. The tanks had stored laundry water from the Building 771 laundry facility, which ceased operations in the late 1950s. Since being taken out of service in 1984, the tanks have been converted to contain fire suppression deluge overflow for Building 771 plenums (EG&G, 1991).

The laundry water contained liquid process wastes that likely contained nitrate, plutonium, uranium, and various other organic and inorganic constituents (EG&G, 1992). Information that was obtained for the HRR study indicated that the location for IHSS 126 as presented in the IAG is inaccurate. The HRR proposed that the boundaries presented in the IAG be redefined to encompass Building 728, which is north of Building 771 (EG&G, 1992).

2.3.7 IHSS 127 - Low-Level Radioactive Waste Leak

IHSS 127 has been defined as a 20- by 100-foot area immediately west of Solar Evaporation Pond 207C (EG&G, 1990). The area is paved and slopes slightly to the north (EG&G, 1990). The IHSS has a gentle to moderate north slope and lies along a dirt road on the west side of Solar Evaporation Pond 207C (EG&G, 1990c).

The location of IHSS 127 as defined in the IAG does not correspond with the location of any process waste lines located on RFP utility drawings. Information gathered for the HRR indicates the location of the process waste line between Building 774 and Building 995 is about 70 feet west of the previously identified IAG location for IHSS 127. It has been proposed that the location of IHSS 127 be redefined to coincide with the location of the PWL (EG&G, 1992).

2.3.8 IHSS 132 - Radioactive Site - 700 Area Site #4 (Building 730)

IHSS 132 has been defined as a 20- by 40-foot area north of Building 776. More specifically, it is centered around Building 730, immediately north of Buildings 776 and east of Building 701 (EG&G, 1990). The surface is relatively flat and mostly unpaved. The area is highly congested with overhead, ground-level, and underground pipes and utilities (EG&G, 1990c).

This unit consists of four 34-year-old concrete laundry waste tanks housed inside Building 730. All four are underground tanks and made of concrete with the sides poured against soils. The tanks are in a valve pit with the tops of the tanks approximately 8 to 10 feet below grade. The bottoms of the tanks would be about 15 to 25 feet below grade. The tops of the tanks serve as the floor of the valve pit. Two of the tanks are 4,500-gallon tanks and two are 22,500-gallon tanks (Doty & Associates, 1992 [Appendix B]). All four of these tanks were removed from service as waste receiving tanks (the 4,500-gallon tanks were decommissioned in December of 1982 and the 22,500-gallon tanks were decommissioned in October, 1984) (EG&G, 1992).

2.3.9 IHSS 135 - Cooling Tower Blowdown - Southeast of Building 374

IHSS 135 has been defined as a 100- by 150-foot area southeast of Building 374, but the cooling tower is actually northeast of the building (EG&G, 1990). The ground surrounding the cooling tower is unpaved and flat, and is lightly used for storage (EG&G, 1990c).

Aerial photographs indicate the cooling tower was present as early as 1978. A June 1, 1980 photo indicates a pond-like structure north of Building 374 at the turn in the asphalt road (EG&G, 1992). Utility drawings support this as the location of the cooling tower retention pond, indicating a "holding pond" where Tank 808A and Tank 808B are now located (EG&G, 1992). According to the HRR (EG&G, 1992) there is documented use of a Building 373 cooling tower pond.

Prior to 1980, water from the cooling tower was allowed to drain into North Walnut Creek (EG&G, 1992). Persons interviewed for the CEARP Phase I report indicated that areas near the Building 374 cooling tower were affected by blowdown water. Building 374 personnel stated that blowdown water is routed through an underground pipe into the RFP's sanitary sewer system for treatment (DOE, 1992). The underground blowdown water pipe runs out through the southwest corner of the cooling tower. It is therefore proposed that IHSS 135 be redefined as a 30 by 75 foot area on the west side of Building 373 (EG&G, 1990c).

2.3.10 IHSS 137 - Cooling Tower Blowdown - Building 774

IHSS 137 has been defined as a 50- by 150-foot area south of Building 774 (EG&G, 1990). Two cooling towers, Buildings 712 and 713, are located in the immediate vicinity of, and are associated with, Building 776 (EG&G, 1992). The land surrounding Buildings 712 and 713 is flat and unpaved. Numerous underground interferences (possibly PWLs) are evident (EG&G, 1990e).

The Building 776 cooling towers blowdown water is treated in the wastewater treatment plant. It is thought that the blowdown water drains from the cooling towers through underground pipes outside the south ends of the buildings (EG&G, 1992).

RFP utilities personnel have indicated that the two cooling towers near IHSS 137 serve Building 776 (not 774) and have been in operation since Building 776 was built in the late 1950s. The towers are alternated seasonally; the west tower (Building 712), which has a higher cooling capacity, operates in the summer, while the east tower (Building 713) operates in the winter. Blowdown water from these facilities is routed into the RFP's sanitary sewer system for treatment (EG&G, 1990c).

The cooling tower blowdown pipes leave the towers on their south sides. It has been proposed that the boundaries of IHSS 137 be redefined to encompass the south ends of Building 712 and Building 713. It has also been proposed to change the dimensions to a 50- by 120-foot area from the existing 50- by 150-foot area (EG&G, 1990c).

2.3.11 IHSS 138 - Cooling Tower Blowdown - Building 779

IHSS 138 has been defined as a 75- by 75-foot area northeast of Building 779 (EG&G, 1990c). The area surrounding the towers is unpaved and relatively flat, and is heavily congested with trailers and storage containers (EG&G, 1990c).

A group of several cooling towers (Buildings 783-787) is located in the vicinity (EG&G, 1990). The present Building 779 cooling towers were built in the early 1980's to replace old towers which were removed from the same location. The original towers had been in operation since Building 779 was completed in the late 1950s (EG&G, 1990c).

The area of the cooling tower water line break is of a smaller extent and located farther to the east than presented in the IAG as IHSS 138. It has been proposed that IHSS 138 be redefined as a 50- by 50-foot area northwest of Building 727 (EG&G, 1990c).

2.3.12 IHSS 139.1(N) and 139.1(S) - Hydroxide Tank Area (Buildings 771 and 774)

IHSS 139.1 has been identified as a 25- by 250-foot area south of Building 771. This IHSS actually consists of two separate areas surrounding two aboveground caustic storage tanks and two aboveground condensate receiving tanks.

The KOH tank is located approximately 55 feet south and 35 feet east of the southeast corner of Building 771 (Rockwell, 1987). It was built some time between 1955 and 1964 (Rockwell, 1964, 1955). The 5,400-gallon tank is of welded construction, and appears to be in good condition presently. It is on a concrete base, which is also in good condition, and is surrounded by a small, eroded, earthen berm (Doty & Associates, 1992 [Appendix B]). It has been suggested that this tank site be identified as IHSS 139.1(S).

The 6,500-gallon NaOH tank is located adjacent to the north side of Building 774. The NaOH tank was built some time between 1955 and 1964 (Rockwell, 1964, 1955). It is vertical and surrounded by insulation, which is in poor condition. Through the holes in the insulation, it is apparent that the sides of the tank are corroded, as is the base of the tank. The tank is surrounded by a corroded berm which is approximately 18 inches high (Doty & Associates, 1992 [Appendix B]).

In addition to the two tanks described above, any discussion of this IHSS should include two 8,000-gallon tanks, which were once used as steam condensate tanks, and are located approximately 45 feet north of the NaOH tank (Rockwell, 1987), and at a lower elevation. These tanks were built some time between 1971 and 1978 (Rockwell, 1978, 1971). The westernmost tank receives overflow and contained liquid from the bermed area around the NaOH tank. The

easternmost tank receives overflow from the westernmost tank. These two tanks, T-107 and T-108, have riveted construction. Currently, there is standing water around the tanks. The bottom of the tanks appear to be corroded, and there is rust on the tops and sides of the tanks (Doty & Associates, 1992 [Appendix B]).

Existing wells in the area include #19189, #19089 (in the north area), and #89389 (in the south area). They were constructed in 1989.

It has been proposed that IHSS 139.1 be informally separated into two units. 139.1(N) consisting of both the NaOH and the steam condensate tanks and 139.1(S) consisting of the KOH tank. It has been proposed that 139.1(N) be comprised of two discrete sites: a 25 by 25 foot area around the NaOH tank, and a 30 by 40 foot area centered around the west condensate receiving tank. It has been proposed that 139.1(S) consist of an "L"-shaped area 25 feet wide and 140 feet long that includes the KOH tank and the line that transfers KOH into Building 771 (EG&G, 1992).

2.3.13 IHSS 139.2 - Hydrofluoric Acid Tank Area (Building 714)

IHSS 139.2 has been defined as a 40- by 60-foot area south of Building 771. More specifically, the area encompasses the hydrofluoric acid (HF) shed (Building 714) south of Building 771 (EG&G, 1990c). The area is flat, includes both paved and unpaved surfaces, and is heavily used. A large above-ground potassium hydroxide storage tank is immediately east of the site (EG&G, 1990c).

Two horizontal, 1,300-pound, HF cylinders, each with a 1,200-pound capacity (Doty & Associates, 1992 [Appendix B]), are located in Building 714, a small shed approximately 4 feet east and 29 feet south of the southeastern corner of Building 771 (Rockwell, 1987). The HF is delivered to the RFP in portable cylinders, which are replaced when empty. No open transfer of the acid takes place (EG&G, 1990). The acid is piped to, and used in, Building 771 (Doty & Associates, 1992 [Appendix B]).

It should be noted that previous discussions of this IHSS indicate that the shed contains two 1,200-gallon aboveground HF tanks. This, however, is not the case. The HF is contained in two 1,300-pound cylinders.

In addition, there is a portable, refillable nitric acid dumpster located just north and west (approximately 25 feet) of the HF storage area discussed in the IHSS 139.2 description. More precisely, the dumpster is located at the southeast corner of Building 771.

The dumpster involved supplies nitric acid to the Building 771 chemical makeup area. The acid is delivered to the 218 tank farm near Building 444 by an outside supplier. One of two available dumpsters is picked up at Building 771, taken to the bulk supply, and filled by Building 774 Chemical Operators. The dumpster is then returned to Building 771. This process occurred on a daily basis when Building 771 was operational as a plutonium recovery facility (Doty & Associates, 1992 [Appendix B]).

The information compiled on IHSS 139.2 for the HRR indicates that the location presented in the IAG is inaccurate. It has been proposed that the location of IHSS 139.2 be redefined to represent the location of the HF storage shed, Building 714. Building 714 is 40 feet south and 10 feet east of the southeast corner of Building 771. This is approximately 350 feet south and 250 feet west of the location presented in the IAG as IHSS 139.2 (EG&G, 1992).

2.3.14 IHSS 144 - Sewer Line Breaks (Building 730, Tanks 776 A-D, Leaks near Buildings 701 and 770)

IHSS 144 has been defined as a 20- by 50-foot area between Building 777 and 779 (EG&G, 1990c). There are four underground waste holding tanks located north of Building 776 and east of Building 701, in a small structure identified as Building 730. They are designated as Tanks 776 A through D. They were built in approximately 1956 (Rockwell, 1976), and were taken out of service in the 1980s. They are now used as plenum deluge tanks (Personal Communication, Ron Teel, RFP Employee, April 10, 1992). The tanks would, therefore, normally be dry. The

area between Buildings 777 and 779 is a narrow, paved alley which slopes down from the north to a level several feet lower than the surrounding ground, giving the appearance that it was excavated. The alley has been paved since 1968, and has sloped to the south since the two buildings were constructed (EG&G, 1990c).

Engineering drawings, specifically D-13493 and 28714-X51, provide additional information about these tanks. The tanks are underground concrete tanks which are beneath a pumphouse. To gain access to the pumphouse, one must go through a ground-level doorway and descend 9.67 feet down stairs. At this level, one is essentially standing on the tanks, which have manhole covers (Doty & Associates, 1992 [Appendix B]).

The top of the pumphouse, which is slightly above the ground surface, is at an elevation of 5,988.0 feet. The floor of the pumphouse, also the roof of the tanks, is at an elevation of 5,978.33 feet. The base of the tanks are approximately 12 feet below the floor of the pumphouse, indicating an approximate base elevation of 5,966.33 feet. The concrete surrounding the pumphouse and tanks is approximately 1 foot thick (Doty & Associates, 1992 [Appendix B]).

The tanks are concrete, and have a 26-foot depth. They are not able to be inspected. The capacity of Tanks 776 A and B are 22,500 gallons each, and the capacity of Tanks 776 C and D are 4,500 gallons each. The dimensions of 776 A and B are 25'x15'x10' each, and those of 776 C and D are 5'x15'x10' each (Rockwell, 1976). Tanks 776 A and B are laundry waste holding tanks, and Tanks 776 C and D are process waste holding tanks. Their design is such that if tanks C and D overflowed, the excess liquid could drain into tanks A and B, and vice versa (Werkema, 1972).

From approximately 1969 until 1973, laundry waste could be transferred through the sewer lines to the sanitary sewer system 3004(U). A pipe header at the tanks allowed alternatives of pumping the laundry water to the sanitary sewer system, the Solar Evaporation Ponds, or Building 774 (Doty & Associates, 1992 [Appendix B]).

On approximately June 1, 1972, a revision of a Building 776 radiography vault floor drain was completed. Apparently, previous transfers of laundry waste water from Tanks 776 A and B resulted in backflow into the vault. The revision to the floor drain, involving relocation of the drain pipe connection, would allow the waste to be transferred at higher pressures (Werkema, 1972).

Groundwater wells #1986 and #2386, which were installed in 1986, and Well #09389, which was installed in 1989, are the only wells in the general vicinity of this IHSS.

It has been proposed that the location of IHSS 144 be redefined to include the location of the clean-out plug overflow east of Building 730 (EG&G, 1992).

2.3.15 IHSS 146.1 - 146.6 - 7,500 Gallon Process Waste Tanks 31, 32, 34w, 34e, 30, and 33 (Building 774)

IHSS 146 represents a six-chambered reinforced concrete structure south of the original Building 774 (Doty & Associates, 1992 [Appendix B]). The chambers of the structure are referred to as Tanks 30, 31, 32, 33, 34W, and 34E. Building 774, a liquid waste processing facility, has been modified several times since its construction in 1952. During the construction of a south addition in 1972, the six tanks were removed.

Tanks 30 and 33 had a 3,000-gallon capacity. The others had a 6,000-gallon capacity. The tanks were included in a 1952 engineering drawing but it is unclear when they were first placed into service. Liquid waste was transferred to or from the tanks through pipes connected with the original process waste lines (OPWL). Manholes were located at the top of each chamber. The walls of the tanks were approximately 10 inches thick. The bottom elevation was approximately 5,955 feet and the tanks were 11'-8" high. The area occupied by the tanks was 22.15 feet (east-west) by 32.5 feet (north-south). The floor of tanks were at the same approximate height as the second floor of Building 774. Ground elevation to the south of the tanks was approximately

5,965 feet. The ground surface south of Building 774 slopes steeply to the north and levels out near the top of the tanks. Because of the steep slope in area, the bottom level of the tanks was near the level of the second floor of Building 774. Therefore, the soil beneath the tanks was adjacent to the rooms on the first floor of the building (Doty & Associates, 1992 [Appendix B]).

Process waste would enter the tanks from the OPWL and be stored for processing in the liquid waste treatment system in Building 774. It is unknown whether the waste was stored before, during, or after treatment stages. Waste characteristics would include both plutonium and uranium radionuclide waste as well as all other constituents of process waste. The waste characteristics cannot be distinguished from specific building processes because Building 774 was the endline treatment facility for all liquid waste until Building 374 was constructed in 1973 (Doty & Associates, 1992 [Appendix B]).

Information for the development of the following discussion was gathered from the review of documents and historical engineering drawings as well as photographs and visual observation of the site. Several discrepancies were identified with the discussion in RCRA 3004(u) (Doty & Associates, 1992 [Appendix B]).

In 1962, a subsurface investigation of the area was done prior to the construction of an addition on the west side of Building 774. Several boreholes were drilled prior to the construction. Soil samples were obtained using both split spoon samplers and Shelby tubes. The results of the laboratory analyses are unknown. A second engineering and geologic investigation of the area was done in 1970 prior to the construction of two additions to Building 774. The construction of one of the additions, a two story addition to the south, called for the removal of the concrete tanks. The addition, Room 241 of Building 774, houses four steel tanks which have replaced the function of the concrete tanks. The finished floor elevation is approximately 5,959 feet. The area occupied by the addition is 55 feet by 64 feet (Doty & Associates, 1992 [Appendix B]).

Tanks #66, #67, and #68 (identified as IHSSs 124.1, 124.2, 124.3, and 125) were located adjacent to the east of the tanks of IHSS 146.1 through 146.6. Tanks #66, #67, and #68 were also concrete process waste holding tanks. These tanks were taken out of service in 1989 (Doty & Associates, 1992 [Appendix B]).

In April 1971, during review of the Building 774 construction design, it was noted that three drains flow into North Walnut Creek from the Building 774 vicinity.

Surface drainage from the hillside south of the building is toward the north. A roadway is located on the top of the slope. Surface runoff is directed away from the building through footing drains which slope to the west around the building and pass under the building through a corrugated metal pipe. The footing drain daylights north of the building, between the western condensate receiving tank (Tank T-108) and Building 770.

The subsurface investigations prepared in 1962 and 1970 identified borehole lithology in the area of Building 774. The surface geology south of the building has changed because of the construction of the addition and removal of contaminated soil. A number of wells are located to the north, south, and especially the east of Building 774, primarily due to the presence of the RCRA-regulated solar ponds (Doty & Associates, 1992 [Appendix B]).

2.3.16 IHSS 149 - Effluent Pipe (southeast and north of Building 774)

IHSS 149 has been defined as a 20- by 550-foot area immediately north of the 207 solar Evaporation Ponds (EG&G, 1990c).

In 1972, two 1.5-inch PVC pipes were installed to transfer wastes between Building 774 and the 207 Solar Evaporation Ponds (EG&G, 1992). These lines which carried low-level radioactive aqueous waste containing caustic and acids, were abandoned in place in 1980 after the vapor compression evaporation Building 374 was constructed (EG&G, 1990c).

The IHSS is at the crest of a hillslope which drops off steeply to the north and is mostly unpaved (EG&G, 1990c).

2.3.17 IHSS 150.1 - Radioactive Site North of Building 771

IHSS 150.1 has been defined as a 50- by 450-foot area north of Building 771 (EG&G, 1990c). This IHSS consists of an area north of Building 771, affected by a radioactive leak. The area encompassing this IHSS is paved, occupied by numerous trailers, auxiliary buildings and storage areas. The surface was repaved 4 to 5 years ago; prior to this the asphalt was badly deteriorated, with soil exposed in many areas (EG&G, 1990c). The soil beneath the pavement is compacted fill because the area had been a fairly steep hillside sloping to the north before the area was developed. The thickness of the compacted fill material varies across the site and increases to the north.

A small prefabricated building used for storage is located west of Building 770. This building was present in 1969 photographs and has been used for equipment storage.

Wastes from Building 771 and materials to be reprocessed in Building 771 were frequently handled and stored in the area north of the building. Building 770, located north of 771, was built in 1965 and has been used as a residue storage area in the past.

From approximately 1962 until approximately 1968, a 5,000-gallon stainless-steel tank was located approximately 30 feet north of Building 771. The tank was on six-foot legs and was approximately 8 feet in diameter. Two overhead pipes from Room 114 in Building 771 connected to the tank; one of which was a vacuum vent to control transfer in and out of the other. The tank was used in the Filtrate Recovery Ion Exchange system, which concentrated plutonium and americium for recovery. Americium was concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank.

The tank was taken out of service following the discovery of a leak and was eventually disposed of (Doty & Associates, 1992 [Appendix B]).

The paved area between Buildings 771 and 770 was used for the storage of residue in drums prior to processing in Building 771. A June 1969 photograph shows over one hundred drums stored in rows on the pavement. A fence parallel to Building 771 also encloses the west entrance to Building 770 and defines a storage area. During the period that the area was used for storage, the paved area also functioned as the access road for Buildings 771 and 774. Drums were also stored in the courtyard south of Building 770 between the access road and the building. This location has since been altered. In the 1960s, there was a concrete embankment wall along the southern and eastern sides of the courtyard, and there is currently no embankment wall. Construction changes in this area are not clear. More information may be found at a future date regarding the physical alteration of the area. Drums of waste from the 1969 fire in Building 776 were stored in the area for counting prior to shipment (Doty & Associates, 1992 [Appendix B]).

The material stored consisted primarily of residues which had a high plutonium content and were destined for plutonium recovery operations in Building 771. Materials were stored in drums on pallets or in cargo containers.

Due to environmental concerns related to the clean-up activities at the 903 storage area and the triangle storage area, sitewide efforts were made in the early 1970s to move all radioactively contaminated materials to indoor storage. The Building 771 area was used for storage until approximately 1974 when Building 776 was used for such storage. Building 770 was then used for the storage of equipment, and also as an equipment assembly facility prior to the installation in other buildings (Doty & Associates, 1992 [Appendix B]).

Several test wells were drilled in the area north of Building 771 in 1962 in preparation for the construction of an addition. One boring was located in the northeastern corner of Building 771 and was drilled to a depth of 36 feet from an elevation of 5,946 feet. Fill existed to a depth of

1 foot, highly weathered claystone to a depth of 15 feet, and weathered claystone to the bottom of the hole. The water table was encountered at 6 feet, although the date of the borings was not provided (Doty & Associates, 1992 [Appendix B]).

Surface water on the pavement generally drains to the west. Prior to the mid-1960s, some surface runoff was able to drain into a strip of grass west of Building 770 between the access road and the Building 771 parking lot. The grass strip was reduced in width in the late 1960s and finally was paved entirely. The area immediately north of Building 770 has a grated collection channel which directs collected water to the east toward a small pond ("Bowman's Pond"). The water in the pond is collected in the Interceptor Trench Pump House system associated with the solar ponds (Doty & Associates, 1992 [Appendix B]).

Information developed on this unit for the HRR indicates that the waste storage and handling also occurred west of Building 770 and possibly north of Building 774. It is proposed that the boundaries for IHSS 150.1 presented in the IAG be revised. Due to the leaking drum incident in June 1968, it is proposed that the IHSS boundaries should be extended to the east approximately 120 feet. In addition, photographs clearly show that in March 1974, over 30 cargo containers were present immediately west of Building 770. The photographs also include close-up shots of the containers and the ground. This area is not presently within the IHSS boundaries. Thus, it is proposed to extend the boundaries of IHSS 150.1 to include the area west of Building 770 (EG&G, 1992).

2.3.18 IHSS 150.2 - Radioactive Site West of Buildings 771

The IHSS 150.2 Has been defined as a 70- by 250-foot area west of Building 771 (EG&G, 1990c). This area west of Building 771 was contaminated by a radioactive leak.

The surface west of Building 771 steps down steeply to the north, with numerous retaining walls, paved and unpaved storage pads, and loading docks. The storage areas hold drums, electrical

equipment, and sheds. This surface west of Building 776 is relatively flat and mostly paved. The area was first paved in 1968 (EG&G, 1990c).

The information developed for the HRR indicates that the location for IHSS 150.2 presented in the IAG is inaccurate. It has been proposed that the IHSS be redefined as a 75- by 600-foot area west of Buildings 776 and 771 (EG&G, 1990c).

2.3.19 IHSS 150.3 - Radioactive Site Between Buildings 771 and 774

IHSS 150.3 has been defined as a 100- by 140-foot area east of Building 771 (EG&G, 1990c). This IHSS consists of an area between Buildings 771 and 774 that was contaminated by a radioactive leak. The south side of the area is relatively flat and mostly paved, while the north side slopes steeply to the north into an unpaved courtyard between Buildings 771 and 774 (EG&G, 1990).

A cement tunnel slopes down from Building 771 to Building 774. This tunnel entered Building 774 on the south wall prior to the southward expansion of the building in 1972. Now the tunnel enters Building 774 from the west wall of the building. The additions to Building 774 account for the apparent discrepancies between drawings of the juxtaposition of the tunnel to Building 774. This tunnel had been under several feet of soil when originally built. However, due to major modifications of the hillside between Buildings 771 and 774, the top of the tunnel is now exposed near Building 774 and is probably not under more than 1 foot of soil at any point. At the northern edge of the tunnel on the slope of the hillside down to the 771/774 courtyard changes from steep to nearly vertical (Doty & Associates, 1992 [Appendix B]).

2.3.20 IHSS 150.4 - Radioactive Site East of Building 750

IHSS 150.4 has been defined as a 120- by 180-foot area northeast of Building 750 (EG&G, 1990). This IHSS consists of an area northwest of Building 750 contaminated by a radioactive leak.

The surface in this area is flat, mostly paved, and used for storage, parking, and loading/unloading for Building 750. The area has been paved since construction of Building 750 in 1969. The area is behind a security fence, and must be accessed through the main gate on the south side of Building 750 (EG&G, 1990c).

As discussed above, in IHSS 150.2 in May 1969 a fire occurred in Building 776-777. Following the fire, the tanks and pumps that handled the decontamination fluid were placed into the Building 750 courtyard. This area was later paved and used for parking (EG&G, 1992c).

It is proposed that the location of IHSS 150.4 be redefined as an area to the northwest of Building 750 (EG&G, 1992c).

2.3.21 IHSS 150.5 - Radioactive Site West of Building 707

IHSS 150.5 is described as a 150- by 250-foot area southwest of Building 707 (EG&G, 1990c).

IHSS 150.5 includes the original Valve Vault 7 location and overlies a number of active and inactive underground PWLs. The original PWL valve vault was removed from the area in March 1973. The vault stored process wastewater from the 800 and 400 areas, which may contain uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, and fluoride (EG&G, 1992).

The surface slopes gently to the east and is unpaved, with the exception of a road running along the west side of Building 707. A single north-south overhead electric line runs through the center of the area. The area is lightly used for storage and by RFP traffic (EG&G, 1990).

Documentation for occurrences at this IHSS was not discovered. However, information was found relating to the overflows of Valve Vault 7 (IHSS 123.1) and the OPWL valve vault (IHSS 123.2). It is proposed that this IHSS be closed (EG&G, 1992).

2.3.22 IHSS 150.6 - Radioactive Site South of Building 779

IHSS 150.6 is described as a 100- by 200-foot area south of Building 779 (EG&G, 1990c). The surface in this area is relatively flat and mostly paved. The area is heavily used by pedestrian traffic. Several overhead pipes serving Building 779 overlie the area, and a permanent trailer (T779A) is also present (EG&G, 1990c).

In June 1969, Building 779 contained an unknown number of drums of radioactive waste. Following a release in 1969, an unknown number of drums of soil were removed for off-site disposal (EG&G, 1990c).

2.3.23 IHSS 150.7 - Radioactive Site South of Building 776

IHSS 150.7 is a 100- by 500-foot area between Buildings 776 and 707 (EG&G, 1990c). This area is occupied by Building 778, a long, narrow, east-west structure. Very narrow, flat "courtyards" separate Building 778 from Building 707 on the south and from Building 776 on the north. These courtyards are isolated by enclosed hallways between the buildings (EG&G, 1990c).

An asphalt roadway was completed in the area on July 22, 1969 (EG&G, 1992). Much of the area between Buildings 776 and 778 is unpaved and inaccessible to vehicles, and is used for light storage and by pedestrians (EG&G, 1990c).

It has been proposed that IHSS 150.7 be redefined as a 40- by 350-foot area between Buildings 776 and 778 due to the contamination resulting from the May 1969 fire in Building 776/777 (EG&G, 1990).

2.3.24 IHSS 150.8 - Radioactive Site Northeast of Building 779

IHSS 150.8 has been defined as an 80- by 120-foot area east of Building 779 (EG&G, 1990). This IHSS consists of an area northeast of Building 779 that was contaminated by a radioactive leak.

The area is flat and includes both paved and unpaved surfaces. It receives moderately heavy use from RFP traffic and as a storage area. Several overhead electric lines servicing Building 779 are present (EG&G, 1990).

2.3.25 IHSS 151 - Fuel Oil Leak (Tank 262 North of Building 374)

IHSS 151 has been defined as a 30- by 35-foot area centered over Tank 262 north of Building 374 (EG&G, 1990).

Tank 262 is a steel, 47,500-gallon, underground storage tank (for #2 fuel oil) installed in 1980. It is overlain by a 15- by 25-foot concrete pad containing control valves and gauges (EG&G, 1990).

The surface around the pad is flat and unpaved (EG&G, 1992).

2.3.26 IHSS 159 - Radioactive Site East of Building 559

IHSS 159 is a 25- by 75-foot area on the east side of Building 559 (EG&G, 1990). Building 559 is located north of Building 561, south of Building 566, west of Building 707, and east of the Protected Area (Doty & Associates, 1992 [Appendix B]).

The ground slopes very gently to the east and includes both paved and unpaved surfaces, as well as a large storage container on a concrete pad (EG&G, 1990). IHSS 159 is located on the east side of Building 559 in an area of both paved and unpaved surfaces and slopes to the east (Doty & Associates, 1992 [Appendix B]).

Occupation of Building 559, the Plutonium Analytical Laboratory, began in 1968. The original construction included the installation of underground, pyrex PWLs beneath and adjacent to Building 559. These lines ranged from 3 to 6 inches in diameter (EG&G, 1990). The lines broke between 1969 and 1972 due to settling and construction activities in the area (EG&G, 1990 and Doty & Associates, 1992 [Appendix B]). In 1972, sometime between March and May 1, the PWL ruptured near the pit. Reportedly, the line from the building perimeter to the holding tanks was replaced with a 4-inch PVC pipe surrounded by a 6-inch stainless-steel pipe (Doty & Associates, 1992 [Appendix B]). A leak in the southern section of the pipeline underlying Building 559 was also found at the same time in 1972 as the leaks discussed above. The leak was located 12 inches from the south wall and 32 feet west of the east end of the tunnel. A bypass of PVC pipe was installed (Doty & Associates, 1992 [Appendix B]). Those parts of the line that were not replaced have been abandoned in place (EG&G, 1990).

In May 1977, flooding caused of a break in the process water supply line, the process line and the shell, the pit was decontaminated, and Building 559 ceased generation of wastewater.

PWLs exited Building 559 in two locations on the east side, connecting at a manhole just east of where the southernmost pipe leaves the building. From there a pipe carried the waste south to the process waste tank area, known as Building 528, or "the pit." Process waste from Building 561 also exits on the east side of the building and is carried to Building 528 (EG&G, 1990c). Process waste exits Building 528 from the southeastern corner and flows to Valve Vault 10. The pipes from Building 528 to Valve Vault 10 are a 2- and 4-inch polyethylene pipe (Doty & Associates, 1992 [Appendix B]).

Building 528 contains a total of three process waste holding tanks, including two 1,800-gallon, 7- by 9-foot tanks and one 500-gallon, 3.5- by 8-foot tank. The stainless-steel tanks have been in existence since approximately 1966 (Rockwell, 1976).

Engineering drawings, specifically 39163-201 and 38551-206, provide additional information pertaining to the tanks located in Building 528. The tanks are located in a "pit" which has a 16-inch thick concrete floor and 16-inch thick concrete walls. The base of the pit is at an elevation of 5,976.50 feet, while the ground surface in the area is at an elevation of 5,998 feet. The tanks stand on legs approximately 3.125 feet high. Access to the tanks requires the use of stairs, which descend to the east. The sump, which is located on the east end of the pit, is 4 feet deep, 2.5 feet wide, and has 1-foot-thick concrete walls (Doty & Associates, 1992 [Appendix B]).

Stormwater runoff in the area of Building 528 at the time of the releases and at the current time flows to the east. However, surface water impacts could be noted to the northwest of this release site due to the presence of footing drains in the area that may be influencing the migration of contaminants in the area. This footing drain is noted due north of Building 561. This footing drain flows to the west and combines with a 12-inch diameter corrugated metal stormwater pipe and daylights on the hillside southwest of Building 771 at approximately N37,414 and E19,961. It appears that this footing drain is related to the underground tunnel that connects Building 559 and 561. Similarly, some migration of contaminants away from the Building 528 area could be taking place in the OPWLs or in the backfill of the OPWLs that once carried process waste from

the Building 528 tanks due east to the original PWL valve vault (Doty & Associates, 1992 [Appendix B]).

There are presently no monitoring wells in the immediate vicinity of this IHSS (Doty & Associates, 1992 [Appendix B]). The information developed for the HRR indicates that the location for IHSS 159 presented in the IAG is inaccurate. Based on recent information, the HRR has proposed that the IHSS be redefined as a 30- by 130-foot area that fully encompasses the glass waste lines east of Building 559. This area also includes the PVC line (which broke in 1977) leading into Building 528 (EG&G, 1990c).

2.3.27 IHSS 163.1 - Radioactive Site Northwest of Building 774

IHSS 163.1 has been defined as a 60- by 150-foot area northwest of Building 774 (EG&G, 1990c). The eastern half of the area is mostly flat and paved and is covered in part by trailer T771G. The area was repaved 4 or 5 years ago. The western half is unpaved, slopes to the north, and is crossed by an unpaved solar evaporation ponds access road (EG&G, 1990c).

CEARP Phase I interviewees indicated the area north of Building 774 was used to wash radioactively contaminated equipment. Building 774 personnel did not recall this area ever being used to wash equipment (EG&G, 1992).

Aerial photos from 1969 and 1971 show two areas east of this IHSS that were covered with mounds of soil. RFP personnel interviewed did not recall these mounds. The mounds are believed to be unrelated to IHSS 163.1 (EG&G, 1990c and 1992).

2.3.28 IHSS 163.2 - Radioactive Site North of Building 771 and 774

IHSS 163.2 has been defined as a 50- by 50-foot area north of Buildings 771 and 774, outside the Protected Area just southeast of Parking Area #71 (EG&G, 1990c). Approximate Rocky Flats coordinates are N751,400; E2,084,050 (EG&G, 1992).

Information for the development of the following discussion was gathered from the review of documents, historical drawings, and historical engineering drawings as well as interviews with Building 771 employees. The information identified for this OU Work Plan found inconsistencies with the discussion presented in RCRA 3004(u).

An americium-contaminated slab is buried in the area near Building T771A by the Perimeter Road. The slab is approximately 8 feet square and 10 inches thick. From approximately 1962 until approximately 1968, the slab served as a foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771. The tank was used in the Filtrate Recovery Ion Exchange system which concentrated plutonium and americium for recovery. Americium was concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank.

Around 1968, the tank was temporarily sealed following the discovery of a leak. Once emptied, the tank was taken out of service. The tank remained in place until it was taken to the size-reduction facility in Building 776 sometime shortly thereafter. When the tank was removed to the size-reduction facility, the concrete slab was decontaminated. The slab was moved to a ditch directly north of the area and buried. The area was paved sometime prior to June 1969. In the mid-1970s, Building T771A, a prefabricated structure, was constructed in the same general area. None of the persons interviewed for this investigation recalled any subsequent excavation of the slab (Doty & Associates, 1992 [Appendix B]). The slab lies underground near or beneath the east end of T771A at a probable depth of less than 10 feet.

An environmental summary report from 1973 does not record the incident in the summary of environmental incidents impacting the soil at the RFP; however, the report does have a notation of the slab on a map of the area north of Building 771. The report indicates an area farther to the north of where the slab is believed to be buried and states that it was later excavated and the contaminated portion cut away for off-site disposal (Doty & Associates, 1992 [Appendix B]). This is not believed to be the case. The location indicated on the map cannot be accurate because it is in an area that was paved several years before the slab became contaminated. As stated above, there has been no verification that the slab was subsequently excavated (Doty & Associates, 1992 [Appendix B]).

The 8- by 8-foot slab is probably still buried beneath the pavement near Building T771A. There was no mention of americium-contaminated soil being buried with the slab. However, because the slab had been located on soil, it is likely that some soil from beneath the slab was also deposited when the slab was pushed into the ditch. Therefore, it is not likely that there is a significant amount of contaminated soil surrounding the slab. Other material of an unknown source was backfilled into the ditch prior to the area being graded and paved (Doty & Associates, 1992 [Appendix B]).

The ditch the slab was buried in formerly directed surface drainage to the west into a tributary to North Walnut Creek. It is not known how long the slab remained in the ditch before the area was paved (Doty & Associates, 1992 [Appendix B]).

The area is on a steep hillside into the North Walnut Creek drainage. The Building 771 parking lot is over approximately 40 feet of fill material right in the drainage. Building 771 was built into the hillside with the roof of the two-story building at ground level along the south wall. The location of the slab is in an area of varying depths of fill over weathered clay bedrock (Doty & Associates, 1992 [Appendix B]).

2.3.29 IHSS 172 - Central Avenue Waste Spill

IHSS 172 follows the path formerly used by vehicles to transport drums of waste between the 903 Pad, where the drums were stored, and the waste treatment facility in Building 771. It spans a distance of approximately 1 mile, crossing the Protected Area southeast of Building 374, and includes: the westbound lane(s) of Central Avenue between the 903 Pad and Sixth Street; the northbound lane(s) of Sixth Street between Central Avenue and the northwestern corner of Building 771; and the dock area, still in use, at the northwestern corner of Building 771 (EG&G, 1990c).

An unknown amount of "low-level material" reportedly spread to the ditch along the northern side of Central Avenue as a result of this spill. 1969 aerial photographs of RFP show that this ditch ran along essentially the entire affected length of Central Avenue. Most of the ditch has since been paved over, lined with concrete, or filled in by subsequent construction (EG&G, 1990c).

Most of the affected roadway has since been repaved and remains heavily used. A section of Central Avenue between Eighth and Tenth Streets was removed in August 1970 and placed in an asphalt dumping area east of Building 881. The section of Sixth Street between Sage Avenue (outside the Protected Area) and the perimeter road within the Protected Area was removed during construction between late 1980 and late 1982. The fate of the removed asphalt is not known (EG&G, 1990c).

Based upon the above information, it is recommended that IHSS 172 be redefined to exclude those portions of the roadway subsequently removed. These include Central Avenue between Eighth and Tenth Streets (approximately 1,050 ft) and Sixth Street between Sage Avenue and the Protected Area perimeter road (approximately 320 feet) (EG&G, 1990c).

2.3.30 IHSS 173 - Radioactive Site - 900 Area (Storage Vaults near Building 991)

This IHSS encompasses Building 991 and associated underground storage vaults (or tunnels) 996, 997, 998 and 999 (these original plant structures have been in operation since 1952). The area lies within the South Walnut Creek drainage, primarily on the south-sloping north side of the drainage (EG&G, 1990c).

The surface around Building 991 is paved, receives moderate to heavy traffic, and is enclosed by a security fence. This area has been paved for over 20 years; the pavement has been disrupted at times by construction and was extended to encompass Building 984, just south of 991, which was built in the 1980s. The remainder of the area is unpaved and lightly used (EG&G, 1990c).

The south dock of Building 991 is located on the west side of the building and is a loading facility for the tunnels. Small parts and equipment were washed in the dock area. Final products containing plutonium and uranium were shipped from the dock, but no raw products were involved in the operations ongoing within Building 991. Acetone and perchloroethene were the solvents used within the building.

The IAG indicates the entire building and the area over the tunnels and vaults should be included in the IHSS primarily because of the age of the structures. The building and the vaults were used to assemble and store final products, which consisted of nickel-plated plutonium. They were not considered a radioactive threat, and there was no documentation found indicating any contamination. It is therefore proposed that this PAC be reduced in size to the south dock area only. Even though there was no documentation found indicating potential for contamination of this area, it is believed from interviews with retired RFP personnel involved with the activities of this area that the south dock would have a greater probability than the building or vaults of being potentially contaminated. The southern half of the building was used for offices and the

northern half for laboratories and research. No documentation exists for the entire building being considered potentially contaminated (EG&G, 1992).

2.3.31 IHSS 184 - Radioactive Site - Building 992 Steam Cleaning Area

IHSS 184 has been defined as a 50- by 50-foot area near Building 992, just southwest of Building 991. It lies entirely within IHSS 173 (EG&G, 1990c).

The Low-Priority Sites report states that this area possibly was used between 1953 and 1978 to steam clean radioactively contaminated equipment and drums. The rinse water was collected in a sump for treatment in the RFP's process waste system.

Building 991 personnel indicated that steam cleaning was done in an area within the southwestern corner of the Building 991, not beside the guard shack or elsewhere outside the building. This was discontinued around 1969 when new cleaning facilities became available. The area was used to clean stainless-steel containers needed to ship materials to other U.S. AEC (now DOE) facilities. These containers were returned empty to Building 991 by the other facilities and were steam cleaned prior to reuse. The steam cleaning was not intended to decontaminate the containers, only to clean them. The cleaning was done on a concrete floor which is still in place. Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building. The drain system is also still in place (EG&G, 1990c).

Building 991 personnel indicated that steam cleaning was discontinued prior to the aerial photo date (EG&G, 1990c).

Based on the above information, it is proposed that IHSS 184 be redefined as an area of unspecified dimensions entirely within the south side of IHSS 173 (EG&G, 1990c).

2.3.32 IHSS 188 - Acid Leak (Southeast of Building 374)

IHSS 188 is an area of unspecified size southeast of Building 374 (EG&G, 1990). The surface was flat and unpaved at the time of the acid leak and was later paved in the mid-1980s (EG&G, 1990).

This IHSS consists of an area southeast of Building 374, contaminated by an acid leak in 1983. The mixed acid most likely was waste metal leaching solution from the 400 complex, and might have contained very trace amounts of heavy metals.

Recent information developed indicates that the IHSS location presented in the IAG is inaccurate. HRR information indicates that the site should be closer to Building 371 and 374 (EG&G, 1992).

2.4 NATURE AND EXTENT OF CONTAMINATION AT IHSSs WITHIN OU8

The description of the nature and extent of contamination presented in this subsection is based on the RFP Historical Release Report (HRR) (DOE, 1992), review of historical photographs, site visits, interviews with former and present RFP employees, and a review and update of IHSS information performed by Doty & Associates as a task included in the preparation of this Work Plan. A copy of the Doty information is included in Appendix B. An extensive volume of analytical data for borehole samples, groundwater, surface water, and sediments in and around OU8 was made available from the Rocky Flats Environmental Database System (RFEDS). Timing for preparation and submittal of this Work Plan did not permit a thorough evaluation of this information as part of the development of the following discussions for each IHSS. The approach of this Plan provides for a thorough evaluation as the initial stage of the RFI/RI to further define the nature and extent of contamination associated with each IHSS (See Section 11.0).

2.4.1 IHSS 118.1 - Solvent Spills West End of Building 730

Nature and Extent of Contamination:

According to the HRR IHSS 118.1, which consists of a 5,000-gallon underground carbon tetrachloride storage tank, was located adjacent to the west side of building 730. In the 1970s, tank overflows occurred during filling operations. Persons interviewed for the CEARP report recalled a spill of 100 to 200 gallons of trichloroethylene north of Building 776 prior to 1970. These persons did not recall any mitigation efforts to control the spill or clean-up operations. However, the practice at that time was to flush the affected areas with large volumes of water. It has been speculated that this spill may actually have been carbon tetrachloride. However, there are conflicting sources indicating the released constituent to be either trichlorethylene or carbon tetrachloride. No documentation was found detailing response to spills which occurred during filling operations in the 1970s (EG&G, 1992a).

On February 26, 1976, corroded piping leaked carbon tetrachloride into the tank's sump pit. What has been described as a "considerable" quantity leaked and was subsequently pumped out of the pit onto the ground. Other documents indicate that this leak was the result of a leaking valve (EG&G, 1992a).

In March of 1976, a small amount of leakage from the pipes in the tank pit was evident. During this time, Health Sciences was continuing soil-gas monitoring beneath the end tank. Industrial Hygiene reported air samples were typically averaging 10 mg/l of carbon tetrachloride. During the month prior to April 15, 1976, the average concentration rose to near 2,000 mg/l of carbon tetrachloride. It was speculated that the tank or its associated pipes in the sump could have been releasing the carbon tetrachloride into the ground (EG&G, 1992a).

During these winter and spring months, there were documented efforts to stop the leakage from the pipes. Documentation was found which detailed the cleanup of spilled liquid, including that pumped onto the ground (Doty & Associates, 1992a).

On June 18, 1981, the tank failed, releasing carbon tetrachloride into the sump. The sump subsequently pumped some of the liquid out onto the ground surface. Temporary storage tanks were to be obtained to collect the liquid. No documentation was found which details the actual use of the temporary storage tanks. The tank was subsequently removed following this failure. One Building 776 employee present at the time of the tank's removal recalled that it appeared sound with no obvious leaks or significant corrosion (Doty & Associates, 1992a).

2.4.2 IHSS 118.2 - Solvent Spill South End of Building 776

Nature and Extent of Contamination:

In June 1981, one of the tanks ruptured and leaked solvent onto the ground, contaminating the soil. An unknown amount of carbon tetrachloride was released in this incident. The tank and the area of the spill were subsequently cleaned up. No documentation was found which further details response to this occurrence. It is not known whether sampling and analysis was conducted to verify the complete removal of soil contamination (EG&G, 1992b).

In addition, leaks, spills, and overflows of unknown quantity have occurred from the tanks during routine filling operations. Table 5 of the IAG indicates that elevated gamma radiation was detected at IHSS 118.2. This elevated level has been attributed to contamination from other nearby sources, such as the 1969 fire in Building 776 (EG&G, 1990).

No wells or boreholes are located in the immediate vicinity of this IHSS. The nearest upgradient well is P114689, which is located approximately 900 feet southwest of the IHSS. The analytical data available for this well are presented in Subsection 2.4.1. The nearest downgradient wells

are wells 2386, completed in bedrock, and 2486, completed in alluvium. They are located approximately 450 feet to the east-northeast. Groundwater samples from well 2386 have been collected since March 1987. A summary of the analytical data for these samples is presented in Table 2-X. The results of the analysis of VOCs in one groundwater sample are the only analytical data available for well 2486. No VOCs were detected in this sample.

Carbon tetrachloride, methylene chloride, trans-1,2-dichloroethene, and TCE have been detected in groundwater samples from Well 2386. Calcium concentrations in groundwater from this well routinely exceed the upper tolerance limit but do not exceed the maximum background concentration. No radionuclides have been detected in concentrations greater than background in groundwater from this well.

Based on the limited amount of data available, it appears that groundwater in the vicinity of IHSS 118.2 may have been impacted by releases from the IHSS. As discussed in Subsection 2.4.1 for IHSS 118.1, the data available for well P114689 are of limited use at this time for defining the nature and extent of contamination associated with this IHSS due to the separation between the well and the IHSS and the lack of groundwater data for this well. The presence of a number of VOCs in groundwater downgradient from this IHSS points to the need for further research into the types and quantities of materials that may have been released from this IHSS, as well as into other possible sources of contamination in the vicinity.

2.4.3 IHSS 123.1 - Valve Vault 7 Southwest of Building 707

Nature and Extent of Contamination:

On April 4, 1983, a check valve in Valve Vault 7 malfunctioned, allowing process wastewater to backflow into the sump. The vault filled with process wastewater and overflowed. The high-water-level alarm system in Valve Vault 7 was apparently inoperative at the time of the overflow. The process wastewater drained into an adjacent storm runoff collection system ditch near the

Eighth Street and Sage Avenue and flowed east toward South Walnut Creek and the B-Series drainage ponds. Runoff was noticed flowing across the former 750 Parking Lot and through the Building 991 normal runoff drainage (Doty & Associates, 1992a).

The release consisted of process wastewater from the 800 and 400 areas, which typically contain uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, and fluoride. The transfer of liquid waste from the holding tanks at Building 881 was discontinued after personnel verified that wastewater was flowing out of Valve Vault 7. Temporary dikes were constructed to contain the overflow. A dam was constructed in the ditch east of the guard shack at Portal #1, and another dam was placed just west of Guard Shack 762. Drainage from the area was diverted to Pond B-1. Attempts were made to remove oil by using chemical absorbent bats. Environmental samples were taken from the vault and other areas of concern. Water was pumped out of the vault and the containment dikes and transferred to Waste Processing by tanker truck. Snow-melt water was retained in the ditch for several days and later transferred to Process Waste Storage (EG&G, 1992a).

The malfunctioning check valve was repaired or replaced, the sump pump was replaced, and repair of the electrical system was initiated. A new type of check valve was ordered for all the check valves in the waste transfer system. The ditch along Sage Avenue between Valve Vault 7 and Ninth Street was cleaned of all visible contamination. The excavated material was stored for drying in the old Building 771 parking lot (EG&G, 1992a).

The HRR states that based on information found in documents reviewed for the HRR, this site has been mislocated on IAG maps in the same area as the OPWL valve vault several hundred feet to the north (Doty & Associates, 1992a). The HRR suggests that based on this information, the proposed boundaries defining this IHSS in the IAG be extended to include the storm runoff collection system ditch near Eighth Street and Sage Avenue and continue to the extent of Pond B-1 (Doty & Associates, 1992a).

2.4.4 IHSS 123.2 - Valve Vault West of Building 707

Nature and Extent of Contamination:

The specific incident that has been described in IHSS 123.2 involved a valve vault on the OPWL. The OPWLs were installed at various times from 1952 until approximately the mid 1970s, and were taken out of service during the period of the mid-1970s to the mid-1980s. The OPWLs were originally laid out with the line from just west of Building 881 to Building 774 consisting of a 3-inch diameter saran-lined pipe encased in a 10-inch diameter vitrified clay pipe (VCP). The OPWLs were typically abandoned in place (Doty & Associates, 1992 [Appendix B]).

This line was originally installed primarily with lampholes; no valve vault was present at the south 45-degree elbow. These lampholes were too narrow for access to the pipe system and were not provided with rungs. The intent of the lampholes was to allow for more efficient repair of the OPWL system should a leak develop due to allowing some narrowing of the location of the leak (Doty & Associates, 1992 [Appendix B]).

Substantial leaks occurred at the two 45-degree elbows on this line due to expansion of the steel pipe from thermally-hot steam condensate discharges from Building 881. Steam condensate flushed the OPWL following the transfer of acidic or other corrosive waste. Leaks of acidic process waste into the secondary containment pipe resulted in additional corrosion of the outside of the steel pipe (Doty & Associates, 1992 [Appendix B]).

One bad leak occurred in December 1958 at the south 45-degree elbow when the pipe broke and process waste followed the containment pipe to the north 45-degree elbow and leaked into a ditch. Approximately 4,050 gallons of waste leaked in this incident (Building 881 had sent 2,700 gallons of laboratory waste, and only 1,350 gallons of waste were received in Building 774). The laboratory waste had a pH of 5.6, 0.51 milligrams per liter (mg/l) of enriched uranium (uranium

235), and 120 mg/l of nitrates. The laundry waste had a pH of 9.4 and 0.51 mg/l of enriched uranium. The elbow was repaired (Appendix F).

It is possible that soils contaminated from problems experienced at the two 45-degree elbows contributed to soil contamination in the area of each elbow in addition to areas along the OPWLs. Since the OPWLs are sloped to allow for gravity drainage, the migration of waste along the backfill of the OPWLs would probably have been from the southern 45-degree elbow (N36,910, E20,560) to the north 45-degree elbow (N37,340, E20,990), a distance of approximately 630 feet. Based on current topography, the OPWL inverts should be approximately 5.5 feet deep and approximately 3.2 feet deep, respectively. Approximately 360 feet of the diagonal OPWL pipe is either buried beneath Buildings 707 and 778, or has been removed for the construction of Buildings 707 and 778. It is possible that the remainder of the diagonal pipe could have been removed during construction activities related to Building 707, but this is considered unlikely (Doty & Associates, 1992 [Appendix B]).

A soil sample taken 1 foot south and 1 foot east of the valve pit for the south 45-degree elbow contained 45 mg/l of nitrate and 0.145 disintegrations per minute per gram of plutonium activity. This soil sample was taken at an approximate depth of 4 feet and is assumed to have been collected in 1976. Building 881 was converted in the mid-1960s to a stainless-steel processing building. Major concentrations of plutonium should not have been expected in this line (Doty & Associates, 1992 [Appendix B]).

The Radiometric Survey, performed at the RFP during the late 1970s and early 1980s, indicated no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) in the areas along the surveyed portions of the alignment of the OPWLs involved in the 1958 incident (Doty & Associates, 1992 [Appendix B]).

2.4.5 IHSS 125 - 14,000-Gallon Holding Tank (Tank #66)

Nature and Extent of Contamination:

The main function of Tanks 66 and 67 was to receive treated liquid decanted from the second-stage batch precipitation process in Building 774. According to personnel interviewed for the development of the closure plan, the tank floors were cleaned, sandblasted, and coated with eight coats of Amercoat No. 55 in 1956. Details regarding the processes that created waste that had been destined for the tanks are provided in the 1989 RCRA Closure Plan. These tanks were taken out of service in September 1989 because they did not meet the requirements for permitting standards (Doty & Associates, 1992 [Appendix B]).

Approximately 4 feet of the north side of the tank was exposed above the ground surface in 1965 photographs. The ground sloped to the north approximately 25 feet to a loading dock on the east wall of Building 774. The ground elevation dropped approximately 12 feet in that distance. In photographs from 1969 and from the 1970 engineering report prior to the construction of an addition to the building, it is clear that an addition to the building was constructed in the area between the loading dock and the tank extended to the east beyond the east side of Tank 66 (Doty & Associates, 1992 [Appendix B]).

Several references to contamination of the environment from the underground concrete tanks near Building 774 have been cited. These tanks are generally believed to be the six concrete waste tanks identified as IHSSs 146.1 through 146.6, but the actual identification of the tanks is inconclusive. These tanks are located only 4 feet west of the concrete Tank 66 and held liquid of similar waste characteristics (Doty & Associates, 1992 [Appendix B]).

One incident that is attributed specifically to Tank 66 occurred in July 1981 when the tank overflowed and spilled an estimated 3,300 gallons of process wastewater onto the ground and pavement east of the tanks. Air samplers were promptly set up and a water sample was collected

(location unknown). Direct and smear count surveys of the pavement were taken and no measurements above background (level unknown) were identified. The water sample analysis indicated about 40,000 dpm/l plutonium. The pH of the sample was 12.0 and nitrate as nitrogen was 5.6 x 10^3 mg/l. (Doty & Associates, 1992 [Appendix B]).

The results of the Radiometric Survey, performed at the RFP during the late 1970s and early 1980s, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 Pci/g) around Building 774 in the area of Tank 66 (Doty & Associates, 1992 [Appendix B]).

2.4.6 IHSSs 126.1 and 126.2 - Out-of-Service Process Waste Tanks, (Building 728)

Nature and Extent of Contamination:

This unit consists of two 25,000-gallon capacity, below-grade concrete waste tanks housed in Building 728. Each tank has an operating capacity of 25,000 gallons. The tanks were built in 1952. The tanks had stored laundry water from the Building 771 laundry facility, which ceased operations in the late 1950s. Since 1984, they have been used as catch tanks for fire water runoff in the event of a fire in Building 771 (EG&G, 1990c).

Persons interviewed for the CEARP Phase I report indicated that these tanks may have leaked during their process waste operational history, although specific information about spills or clean-up efforts is lacking (EG&G, 1990c). According to the HRR, the tanks leaked, allowing groundwater to periodically flow into them. The groundwater was then pumped into the process waste system. These tanks overflowed several times prior to 1956 (EG&G, 1992).

These tanks likely contained nitrate, plutonium, uranium, and various other organic and inorganic constituents (EG&G, 1992).

No documentation was found which detailed a response to a release from these tanks (EG&G, 1992).

Information that was obtained for the HRR study indicated that the location for IHSS 126 as presented in the IAG is inaccurate. The HRR proposed that the boundaries presented in the IAG be redefined to encompass Building 728, which is north of Building 771.

2.4.7 IHSS 127 - Low-Level Radioactive Waste Leak

Nature and Extent of Contamination:

Persons interviewed for the CEARP recalled that construction activities near Building 774 and west of Solar Evaporation Pond 207C resulted in the breakage of a low-level radioactive waste discharge line several times. The pipe carried aqueous waste high in nitrates with small amounts of plutonium (EG&G, 1990c) from the process waste treatment facility to the sanitary wastewater treatment plant (EG&G, 1992).

On October 14, 1957, a line that carried process waste between Building 774 and the 200,000-gallon waste holding tank leaked at a joint. It was determined that the joint had not been properly packed during construction (EG&G, 1992).

Leakage was detected in 1971 when the waste line between Building 774 and Building 995 was pressure tested (EG&G, 1992). The leaking section was replaced in April 1982. A soil sample was collected in 1976 from a depth of 4 feet beside the leak area, just north of Tank 207 and south of Building 774. This sample showed 76 ppm nitrate and 1.83 dpm/g Pu^{239} (EG&G, 1992).

The location of IHSS 127 as defined in the IAG does not correspond with the location of any PWLs located on RFP utility drawings. Information gathered for the HRR indicates the location of the PWL between Building 774 and Building 995 is about 70 feet west of the previously

identified IAG location for IHSS 127. It has been proposed that the location of IHSS 127 be redefined to coincide with the location of the PWL (EG&G, 1992).

2.4.8 IHSS 132 - Radioactive Site - 700 Area Site #4 (Building 730)

Nature and Extent of Contamination:

This unit consists of four 34-year-old concrete laundry waste tanks housed inside Building 730. All four tanks are underground tanks made of concrete with the sides poured against soils. The tanks are in a valve pit with the tops of the tanks approximately 8 to 10 feet below grade. The bottoms of the tanks would be about 15 to 25 feet below grade. The tops of the tanks serve as the floor of the valve pit. Two of the tanks have 4,500-gallon capacity, and two have 22,500-gallon capacity (Doty & Associates, 1992 [Appendix B]). These tanks are suspected of having had overflows of laundry waste, although utilities personnel stated that they believed this unlikely because the laundry tanks were never fully filled (EG&G, 1990).

On September 23, 1975, there was a slight spill onto the ground "near Building 776" during the removal of contaminated process waste sludge from the underground concrete holding tanks. Reports indicate that the clean-out of a waste tank "north of Building 776" caused contamination to the environment and a cement truck. The incident involved radioactively contaminated sludge that had accumulated in the tank; this was cleaned up in an undescribed manner (EG&G, 1992).

On July 30, 1979, laundry tanks overflowed in the "new pit." Following this incident, six smear samples were taken and showed activities of less than 20 dpm (EG&G, 1992).

All four of these tanks were removed from service as waste receiving tanks (the 4,500-gallon tanks were decommissioned in December of 1982 and the 22,500-gallon tanks were decommissioned in October 1984) (EG&G, 1992). RFP utilities personnel indicated that the 22,500-gallon tanks, on the south side of Building 730, were cleaned, painted with several layers

to block alpha emissions, and converted to catch tanks for firewater from Building 771 plenum deluge system (IT, 1990). RFP personnel further stated that the 4,500-gallon underground storage tanks on the north side were simply abandoned in place without decontamination (IT, 1990). Reference documents suggest that all four tanks are subject to occasional fill-up with groundwater (EG&G, 1992). However, utilities personnel have indicated that no groundwater infiltrates the two 22,500-gallon tanks. Personnel were uncertain about groundwater in the 4,500-gallon underground tanks. They stated that no groundwater has ever been pumped from the two underground tanks into the waste system. While not aware of specific leaks, they did believe that leakage into the soil from the tanks was likely because of their condition (Doty & Associates, 1992 [Appendix B]).

2.4.9 IHSS 135 - Cooling Tower Blowdown - Southeast of Building 374

Nature and Extent of Contamination:

During routine cooling tower operations, evaporation gradually concentrates dissolved solids in the cooling water. To prevent salt buildup, a portion of the water is removed and replaced with fresh water. This is done continuously in some RFP towers and as needed in others. The removed blowdown water is treated either in the RFP's sanitary sewer system or in the waste treatment system, whichever is more convenient to the particular tower. The water typically contains a corrosion-inhibiting additive. Since the late 1970s, RFP has used phosphate for this purpose; prior to this time, a chromate additive was used. It is possible that prior to 1980, effluent from the cooling tower may have contained tritium, although it is not certain what the tritium source would be (EG&G, 1992). Standard chlorine bleach or a similar biocide is also added to the water to prevent algae growth (EG&G, 1990).

Persons interviewed for the CEARP Phase I report indicated that areas near the Building 374 cooling tower were affected by blowdown water. Building 374 personnel stated that blowdown water is routed through an underground pipe into the RFP's sanitary sewer system for treatment.

They recalled no leaks or other incidents involving blowdown water from Building 374. Any leakage or blowdown water from a source other than the underground pipe would be contained within the cooling tower building and would not affect soils around the tower (EG&G, 1990).

According to the HRR (1992) there is documented use of a Building 373 cooling tower pond. The first documented use was on June 12, 1981. The cooling tower was cleaned, and the slurry portion was pumped into a small retention pond. During the night, some of the water leaked through the dirt dike and gate valve and drained into Walnut Creek (EG&G, 1992).

A June 1, 1980, photo indicates a pond-like structure north of Building 374. Utility drawings support this as the location of the cooling tower retention pond, indicating a "holding pond" where Tank 808A and Tank 808B are now located. The drawings indicate a sluice gate at the northeast corner of the pond with connecting culvert that extends from it in a northeasterly direction. It is possible that the leak mentioned above was able to flow through this culvert to North Walnut Creek (EG&G, 1992).

2.4.10 IHSS 137 - Cooling Tower Blowdown - Building 774

Nature and Extent of Contamination:

Buildings 712 and 713 are both cooling tower facilities associated with Building 776. Interviewees for CEARP mentioned a release of cooling water south of Building 774 that flowed into Walnut Creek. This water contained 50 mg/l total chromium. It is speculated that they were recalling a release from the Building 779 cooling tower in December 1976 (EG&G, 1992).

The Building 776 cooling towers blowdown water is treated in the wastewater treatment plant. It is thought that the blowdown water drains from the cooling towers through underground pipes outside the south ends of the buildings (EG&G, 1992).

A leak in a cooling tower within the Protected Area was reported to have occurred between August 20 and September 6, 1990. A memorandum was sent to utilities personnel expressing the need to fix the leaks caused by corroded metal sides. Contact with the author of the document verified that the leak came from either Building 712 or Building 713. The leak has been estimated at a flow rate of between 5 and 20 gallons per minute. The duration of the leak is unknown but could have occurred over several months prior to reporting (EG&G, 1992).

Reference 1 indicates the cooling tower blowdown pipes leave the towers on their south sides. These pipes are considered the most probable source of any blowdown water contamination around the cooling towers.

2.4.11 IHSS 138 - Cooling Tower Blowdown - Building 779

Nature and Extent of Contamination:

On December 8, 1976, about 400 gallons of cooling tower water containing chromium and some radioactivity leaked into a storm drain near Building 779. The spilled water was believed to have flowed toward collection trench number six. Utilities personnel at RFP recalled that the 1976 spill occurred when an underground cooling tower water line broke east of Building 779 and adjacent to the northwest of Building 727. The cooling tower water was sampled following the incident and found to contain 50 ppm total chromium and approximately 3,000 dpm/l alpha activity. The ruptured line was excavated and repaired. The cooling tower water line which ruptured in the incident was removed when the original cooling towers were replaced (EG&G, 1992).

On December 8, 1990, an estimated 1,000 gallons of cooling tower water overflowed from the Building 783 number 2 cooling tower onto the ground. The released water was sampled and was known to contain "Nalco 2826," an inorganic phosphate rust inhibitor. There is no documentation to describe clean-up efforts for this spill (EG&G, 1992).

2.4.12 IHSSs 139.1(N) and 139.1(S) - Hydroxide Tank Area (Buildings 771 & 774)

Two caustic tanks, a 5,400-gallon potassium hydroxide (KOH) tank south of Building 771 and a 6,500-gallon sodium hydroxide (NaOH) tank north of Building 774, have been subject to spills and leaks in the past (Doty & Associates, 1992 [Appendix B]).

Included in this discussion will be the two steam condensate tanks described in Section 2.4.__. The westernmost tank receives overflow and contained liquid from the bermed area around the NaOH tank. The easternmost tank receives overflow from the westernmost tank. These two tanks, T-107 and T-108, have riveted construction. Currently, there is standing water around the tanks. The bottom of the tanks appear to be corroded, and there is rust on the tops and sides of the tanks (Doty & Associates, 1992 [Appendix B]).

During the week ending May 5, 1978, a spill occurred during the routine filling of a caustic tank near Building 771. Neither the specific tank nor the quantity spilled was documented. The spilled caustic was contained by a dike below the tank, and was not released to the environment. During March 1985, a pinhole-sized leak was found in the piping from the NaOH tank at Building 774. The leak occurred inside the building, "and probably did not contribute to the caustic material found on the ground in the pit surrounding the tank." Apparently, the leak had seeped along the underground pipe to the outside of the building. The leak was later repaired. The "caustic material found in the pit" was attributed to a poor sampling technique which allowed the valve to drip on the ground. It was estimated that 80 to 100 gallons of caustics had spilled as a result of this method over the 30-year history of the tank. The pit was to be cleaned out and lined in response to the problem. No documentation was found detailing the cleaning or lining of the pit (Doty & Associates, 1992 [Appendix B]).

In May 1985, A small leak was found at the fitting of a thermocouple in the NaOH tank north of Building 774. The caustics had solidified at the fitting, and therefore had not run into the pit. The fitting was repaired (Doty & Associates, 1992 [Appendix B]).

On June 22, 1987, there was an overflow of NaOH during delivery operations to the 6,000-gallon Building 774 caustic supply tank because of a faulty level indicator. (It is believed that this was actually the 6,500-gallon NaOH tank.) Approximately 100 gallons of caustic material flowed into the bermed containment area of the tank and then drained to the caustic "catch" tank, T-108. Due to cracks in and deterioration of the concrete berm, caustic seeped onto the road. Tank T-108 was also found to be deteriorating, and showed signs of seepage. In response to the incident, the 1 to 2 gallons that had seeped onto the road was diluted with water and rinsed off the road. Work orders to repair the cracks in the berm were initiated, and the work was completed on June 24. A job order was submitted to replace the deteriorating catch tank, T-108. The liquid in T-108 was sampled and was to be subsequently pumped to the sanitary sewer system or Building 774. The level indicator on the caustic tank was repaired (Doty & Associates, 1992 [Appendix B]).

On November 13, 1989, approximately 5 gallons of 12 molar KOH was spilled when a vendor was refilling the holding tank near Building 771. Apparently, the tank was overfilled and the extra liquid spilled into an earthen berm surrounding the tank. The KOH was absorbed with approximately 100 pounds of "oil dry," a chemical absorbent, and the contaminated soil and "oil dry" were placed in an 83-gallon salvage drum. Soil samples were taken, and pH analyses were performed. It was determined that all KOH-contaminated material had been removed. The area was backfilled with new gravel. It is possible that the overflowing liquid infiltrated into the soil beneath Building 771 (Doty & Associates, 1992 [Appendix B]).

There is limited data available that would assist in the definition of the nature and extent of contamination associated with releases from IHSSs 139.1(S) and 139.1(N). There are no wells located near or downgradient from the site of the NaOH releases (IHSS 139.1(N)). The nearest wells upgradient and downgradient from IHSS 139.1(S) are the same as those discussed in Subsections 2.4.1 and 2.4.2 for IHSSs 118.1 and 118.2.

The available data from these wells do not indicate any impacts that may be attributable to this IHSS. Due to the nature of the liquids released from these IHSSs, it is unlikely that any residual impact to any environmental media would be detectable except in the immediate vicinity of the releases. The constituents that would be detected in excessive concentrations, potassium and sodium, are both naturally occurring elements. Therefore, elevated concentrations of these elements may not necessarily be indicative of contamination attributable to these releases.

2.4.13 IHSS 139.2 - Hydrofluoric Acid Tank Area (Building 714)

Nature and Extent of Contamination:

IHSS 139.2 consists of two horizontal, 1,300-pound hydrofluoric acid (HF) cylinders, each with a 1,200-pound capacity, that are located in Building 714 (a small shed approximately four feet east and 29 feet south of the southeastern corner of Building 771). The hydrofluoric acid is delivered to the RFP in portable cylinders, which are replaced when empty. No open transfer of the acid takes place. The acid is piped to and used in Building 771 (Doty & Associates, 1992 [Appendix B]).

During May 1971, there was a small vapor release from the hydrofluoric connection outside Building 771. No documentation was found which detailed a response to the release (Doty & Associates, 1992 [Appendix B]).

During the week ending August 13, 1976, a hydrofluoric acid leak above Building 771 was repaired. Apparently, the hoses had collected small amounts of the acid that appeared when the line was pressurized (Doty & Associates, 1992 [Appendix B]).

It is improbable that the acid releases have a residual impact on the air. There was no documentation of events that may have impacted the soil, surface water, or the groundwater.

Additionally it is improbable that there was impact on surface water or groundwater (Doty & Associates, 1992 [Appendix B]).

In addition to the above description of IHSS 139.2, there is a portable, refillable nitric acid dumpster located just north and west (approximately 25 feet) of the hydrofluoric acid storage area discussed in the IHSS 139.2 description. More precisely, the dumpster is located at the southeast corner of Building 771. It is possible that leaks and spills in the vicinity of the dumpster have impacted the environment, as well as those effects on the environment resulting from incidents at the hydrofluoric acid supply area. Low pH soils and groundwater in the area at the hydrofluoric acid tank may be due to releases of hydrofluoric acid, nitric acid, or both (Doty & Associates, 1992 [Appendix B]).

According to Supervisor Investigation Report #87-7-771.1 - Acid Spill, there was a release of approximately 35 gallons of 12 normal nitric acid at the dumpster on July 1, 1987. The cause was a leak in the supply hose. Neutralization was attempted by the use of potassium hydroxide flake and sodium bicarbonate. The following day, the soil was loosened and more sodium bicarbonate was added. An asphalt layer was discovered approximately 6 inches below the ground surface. The affected soil was removed, and new road mix was to be placed on the asphalt pad (Doty & Associates, 1992 [Appendix B]).

The dumpster involved supplies nitric acid to the Building 771 chemical makeup area. The acid is delivered to the 218 tank farm near Building 444 by an outside supplier. One of two available dumpsters is picked up at Building 771, taken to the bulk supply, and filled by Building 774 Chemical Operators. The dumpster is then returned to Building 771. This process occurred on a daily basis when Building 771 was operational as a plutonium recovery facility (Doty & Associates, 1992 [Appendix B]).

The nearest wells to this IHSS that may assist in evaluating the nature and extent of contamination associated with the IHSS are the same as those discussed in Subsections 2.4.1 and

2.4.2 for IHSSs 118.1 and 118.2. The data from these wells do not indicate any impacts that may be attributable to IHSS 139.2. Any residual impact from these releases would likely be confined to the immediate vicinity of the IHSS.

2.4.14 IHSS 144 - Sewer Line Breaks (Building 730, Tanks 776 A-D, Leaks near Buildings 701 and 779)

Nature and Extent of Contamination:

There are four underground waste holding tanks located north of Building 776 and east of Building 701, in a small structure identified as Building 730. They are designated as Tanks 776 A through D. They were built in approximately 1956, and were taken out of service in the 1980s. They are now used as plenum deluge tanks. Therefore, the tanks would normally be dry (Doty & Associates, 1992 [Appendix B]).

The tanks are concrete and 26 feet deep. They are non-inspectable. The capacity of Tanks 776 A and B is 22,500 gallons each, and the capacity of Tanks 776 C and D is 4,500 gallons each. Tanks 776 A and B are laundry waste holding tanks, and Tanks 776 C and D are process waste holding tanks. If tanks C and D overflowed, the excess liquid could drain into Tanks A and B, and vice versa (Doty & Associates, 1992 [Appendix B]).

From approximately 1969 until 1973, laundry waste could be transferred through the sewer lines to the sanitary sewer system. A pipe header at the tanks allowed alternatives of pumping the laundry water to the sanitary sewer system, the Solar Evaporation Ponds, or Building 774 (Doty & Associates, 1992 [Appendix B]).

On approximately June 1, 1972, a revision of a Building 776 radiography vault floor drain was completed. Apparently, previous transfers of laundry waste water from Tanks 776 A and B resulted in backflow into the vault. The revision to the floor drain, involving relocation of the

drain pipe connection, would allow the waste to be transferred at higher pressures (Doty & Associates, 1992 [Appendix B]).

On June 7 or 8, 1972, the increased pumping rate during a transfer of laundry wastewater from Tanks 776 A and B to Building 995 caused suspension of high-level sediment in the tanks and pressurization of the sanitary waste line. The pressurization of the line caused a toilet and sink in Building 701 to overflow and a patch to rupture in the line east of the waste holding tanks. Due to the overflow of the toilet and sink, the toilet, sink, and floor of Building 701, as well as the ground east of the building, were contaminated. The patch that ruptured was apparently located between Buildings 777 and 779. At the time of the incident, maintenance may have consisted of cleaning out a clean-out plug near Building 701, further increasing the potential impacts on the environment (Doty & Associates, 1992 [Appendix B]).

Activities of samples taken from the toilet bowl in Building 701 were as high as 136,000 pCi/l on June 7 and 8. A sludge sample taken from a clean-out plug in the Building 701 sanitary sewer line contained only minimal radioactivity. Analyses of the sediments from the bottoms of Tanks 776 A, B, and D indicated liquid phase activities of 68,000 pCi/l, 9,100 pCi/l, and 302,000 pCi/l, respectively (Doty & Associates, 1992 [Appendix B]).

Interviewees for CEARP Phase I recalled a sewer line break between Buildings 779 and 777, which was discovered when contamination was found in a restroom. It is believed that this is the same incident as the 1972 patch rupture discussed above.

The rupture in the line patch east of the tanks resulted in soil contamination. Approximately 50 drums of soil were removed. A conflicting document states that 38 drums of soil were removed. The contaminated soil around Building 701 was also apparently removed. It is probable that residual soil contamination is present. As of June 8, 1972, 19 drums of soil had been removed. No soil count was detected at that time (Doty & Associates, 1992 [Appendix B]).

The radiometric survey performed in the late 1970s and early 1980s indicated no extremely contaminated (500,000 to 1,000,000 pCi/g) areas at or near this IHSS (Doty & Associates, 1992 [Appendix B]).

Following the 1972 pressurization incident, the Building 995 outfall and other downstream points were sampled daily. There was increased radioactivity in the 995 outfall. The highest sample concentration of total alpha-emitting radionuclides in the outfall was 417 pCi/l, on June 11, 1972 (Doty & Associates, 1992 [Appendix B]).

It is possible that the laundry waste had an impact on the groundwater in the area. Wells 1986 and 2386, which were installed in 1986, and well 09389, which was installed in 1989, are the only wells in the general vicinity of this IHSS (Doty & Associates, 1992 [Appendix B]).

2.4.15 IHSSs 146.1 to 146.6 - 7,500 Gallon Process Waste Tanks 31, 32, 34w, 34e, 30, and 33 (Building 774)

Nature and Extent of Contamination:

Process waste would enter the tanks from the OPWL and be stored for processing in the liquid waste treatment system in Building 774. It is unknown whether the waste was stored before, during, or after treatment stages. Waste characteristics would include both plutonium and uranium radionuclide waste as well as all other constituents of process waste. The waste characteristics cannot be distinguished from specific building processes because Building 774 was the endline treatment facility for all liquid waste until Building 374 was constructed in 1973 (Doty & Associates, 1992 [Appendix B]).

Tanks 66, 67, and 68 (identified as IHSSs 124.1, 124.2, 124.3, and 125) were located adjacent to the east of the tanks of IHSS 146.1 through 146.6. Tanks 66, 67, and 68 were also concrete

process waste holding tanks. These tanks were taken out of service in 1989 (Doty & Associates, 1992 [Appendix B]).

Although it was generally believed that the presence of the concrete waste tanks had an impact on the environment, no documentation was found that detailed specific events. Two events were documented in 1973 involving infiltration of the process waste into the soil: In October 1956, the process waste tanks at Building 774 overflowed, resulting in minor environmental infiltration. In August 1957, some of the tanks leaked, resulting in minor environmental infiltration with levels of up to 2,500 disintegrations per minute (dpm) per gram gross alpha (Doty & Associates, 1992 [Appendix B]).

In April 1971, during review of the Building 774 construction design, it was noted that three drains flow into North Walnut Creek from the Building 774 vicinity. Samples from the Building 774 footing drain contained 400 dpm/l plutonium and 800 ppm nitrate. The concrete tanks were believed to be the source of the plutonium contamination. Corrective action was the scheduled removal of the tanks (Doty & Associates, 1992 [Appendix B]).

During excavation and additions for the Building 774 begun in February of 1972, contamination resulting from the overflow of the tanks was detected. At the time, the policy on waste disposal guidelines required soil samples in excess of 34 dpm/g plutonium activity be disposed of as contaminated waste. Radiometric monitoring procedures included an alpha survey meter evaluation of the site to be excavated. Readings in excess of 250 cpm required specific soil samples to be collected for further analysis. Soil contamination in the excavation was identified as slightly below the 34 dpm/g limit and by April 1972, 101 barrels of contaminated soil were reportedly shipped to Idaho Falls. It was estimated that 30 to 40 more barrels would follow (Doty & Associates, 1992 [Appendix B]).

Demolition of the concrete tanks began on May 8, 1972. A wet-saw cutting method was used for the removal of the tanks. The disposition of the concrete is unknown. Approximately 200

cubic yards of soil contaminated with up to 2,500 dpm/g plutonium from around the tanks were moved temporarily to an area north of Building 334. Another 60 cubic yards of soil contaminated with up to 250 dpm/g plutonium were moved to an area east of Building 881 and buried beneath approximately 3 feet of fill dirt. The 60 yards of soil is now in an area identified as IHSS 130.

In January 1973, 12 soil samples were taken from the 200 yards of soil piled near Building 334. The results of the analysis ranged from 2.8 to 704.2 dpm/g gross alpha with an average of 173 dpm/g. The values convert to a range of 1.3 to 316.9 pCi/g and 13 to 3,169 mCi/km (Doty & Associates, 1992 [Appendix B]).

In February 1973, the soil pile was moved temporarily from the area north of Building 334 to the Triangle Area (IHSS 165) east of the solar ponds because it was in the way of Building 371 construction. A series of soil samples collected from the pile on June 18, 1973, indicated levels of contamination with an average of 87 dpm/g. The soil was on plastic sheeting and had been treated with coherex, a soil stabilizing agent, to reduce erosion. The soil was removed for landfill disposal on September 5, 1973 (Doty & Associates, 1992 [Appendix B]).

The results of the Radiometric Survey performed at RFP during the late 1970s and early 1980s indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) around Building 774 in the area of the former location of the concrete tanks (Doty & Associates, 1992 [Appendix B]).

Much of the soil surrounding the concrete tanks was removed during the construction of the addition and demolition of the tanks. At least 285 cubic yards of contaminated soil were removed. At the time the tanks were removed, radiometric surveys operated off of an action limit of 250 dpm/g gross alpha (about one quarter of the scale of the instruments). For soil contamination measured below this limit, no further action was taken. It is not unlikely that soil contamination would be present in the area beneath the south addition of Building 774 below 250

cpm. Because of the steep slope in area, the bottom level of the tanks was near the level of the second floor of Building 774. Therefore, the soil beneath the tanks was adjacent to the rooms on the first floor of the building (Doty & Associates, 1992 [Appendix B]).

2.4.16 IHSS 149 - Effluent Pipe (Southeast and North of Building 774)

Nature and Extent of Contamination:

In 1972, two 1.5-inch PVC pipes were installed to transfer wastes between Building 774 and the 207 Solar Evaporation Ponds (EG&G, 1992). These lines, which carried low-level radioactive aqueous waste containing caustics and acids, were abandoned in place in 1980 after the vapor compression evaporation Building 374 was constructed (EG&G, 1990).

Sometime during June or July of 1973, a contractor broke the plastic line that ran from the evaporation ponds to Building 774. Repairs were made, and the water continued to be drawn to the ponds (EG&G, 1992).

In the late 1970s, a PWL break southeast of Building 774 resulted in a release of liquid which flowed around to the front of the building. Another, more detailed document reports that on July 21, 1980, an 8-year-old PWL was discovered leaking southeast of Building 774. Process wastewater was observed seeping up in the soil on the south side of the road southeast of Building 774. The leaking process wastewater flowed downslope and through a 30-foot culvert, along the east chain-link fence and under the fence at the corner. From this point, the liquid flowed under the unpaved access road into a boggy area (this area is not considered a wetland (EG&G, 1990)), the 771/774 Footing Drain Pond, north of Building 774. The vegetation in the boggy area was damaged where the spilled liquid formed a pool. It was estimated that approximately 1,000 gallons leaked from the PWL (EG&G, 1992).

The initial response to the July 1980 incident was to stop the flow through the waste line causing the leak to stop. When the soil dried, a FIDLER survey was conducted and verified that the flow did not go beyond the 771/774 Footing Drain Pond. On July 24, the broken waste line was excavated and the problem identified as a loose flange. Soil excavation began July 28, 1980, with radiation monitors checking the soil as it was excavated (EG&G, 1992).

IHSSs AT AREA 150

The eight IHSS 150 areas were identified by persons interviewed for the CEARP Phase I report as having been contaminated by various radioactive liquid releases over the course of RFP's operating history. Most of the contamination resulted from aqueous process waste leaks containing radionuclides, caustics, and acids. Process waste spills have occurred in the 700 Area as a result of broken waste lines, waste backups in lines, and physical degradation of storage tanks and drums.

Another major source of contamination to the IHSS 150 areas was the May 1969 fire in Building 776/777. Although little contamination was released outside the buildings as a direct result of the fire, water used to extinguish the blaze spread plutonium to outside areas. Most of the areas affected by these incidents are believed to have subsequently been decontaminated, either during spill response activities or during the 1975-1983 radiometric survey (EG&G, 1990).

2.4.17 IHSS 150.1 - Radioactive Site North of Building 771

Nature and Extent of Contamination:

Wastes from Building 771 and materials to be reprocessed in Building 771 were frequently handled and stored in the area north of the building. Building 770, north of 771, was built in 1965 and has been used as a residue storage area in the past. Activities in and around Building 770 have contributed contamination to this site (EG&G, 1990).

The following is a chronological breakdown of incidents that have occurred in this area and utilization changes.

On September 11, 1957, the RFP's first major fire occurred in Building 771. A plenum was breached releasing an unknown amount of radioactivity around the building, particularly to the north. The impact the airborne radioactivity may have had on the access road was not quantified; however, fire clean-up activities followed the incident (Doty & Associates, 1992 [Appendix B]).

From approximately 1962 until approximately 1968, a 5,000-gallon stainless-steel tank was located approximately 30 feet north of Building 771. The tank was on 6-foot legs and was approximately 8 feet in diameter. Two overhead pipes from Room 114 in Building 771 connected to the tank, one of which was a vacuum vent to control transfer in and out of the other. The tank was used in the Filtrate Recovery Ion Exchange system, which concentrated plutonium and americium for recovery. Americium concentrated on an ion exchange column and was transferred at a predetermined concentration to the tank. The resulting liquid contained in the tank was a nitrate solution high in americium with some plutonium (Doty & Associates, 1992 [Appendix B]).

In approximately 1968, a pinhole leak developed in the tank and dripped onto the slab foundation. The tank was temporarily sealed to mitigate the leak until the tank could be emptied through the processing of the contained solution. Once emptied, the tank was taken out of service and remained in place until it was moved to the size-reduction facility in Building 776 sometime shortly after. Once size-reduced, the tank was disposed of as radioactive waste. When the tank was removed to the size-reduction facility, the concrete slab was decontaminated until the point where smear samples did not detect further removable radioactivity. Paint was applied to the concrete to secure the fixed radioactivity. The slab was moved to a ditch directly north of the area and buried (IHSS 163.2). The area was paved sometime prior to June 1969 (Doty & Associates, 1992 [Appendix B]).

On June 11, 1968, during the removal of drums from the 903 Storage area, a drum leaked on the roadways as it was being transported to Building 774. The forklift carrying the leaking drum traveled across the access road north of Building 771. The area near Building 774 was contaminated at the time. The road in front of Building 771 was apparently not considered to be impacted by the incident. Further details of this incident are provided in the IHSS 172 description (Doty & Associates, 1992 [Appendix B]).

The paved area between Buildings 771 and 770 was used for the storage of residue in drums prior to processing in Building 771. A June 1969 photograph shows over one hundred drums stored in rows on the pavement. A fence parallel to Building 771 also encloses the west entrance to Building 770 and defines a storage area. Drums were also stored in the courtyard south of Building 770 between the access road and the building. This location has since been altered, because in the 1960s there was a concrete embankment wall along the south and east sides of the courtyard. There is currently no embankment wall. Construction changes in this area are not clear. More information may be found regarding the physical alteration of the area. Drums of waste from the 1969 fire in Building 776 were stored in the area for counting prior to shipment (Doty & Associates, 1992 [Appendix B]).

Another specific incident of contamination occurred on November 16, 1970 when residue leaked out of a drum of filters as it was being transported from a storage area (triangle area east of the solar ponds) to Building 771 for processing. The ground area near the dock at Building 771 as well as the truck and cargo container the drum had come in contact with were all contaminated. The leak was detected while in transit, and the area was decontaminated. It was noted in March 1971 that a significant increase in the number of "hot waste" drums were stored outside in the area north of Building 771. These drums contained residues for the Building 771 incinerator and the number of drums in storage was becoming problematic for the Health Physics Operations Group (Doty & Associates, 1992 [Appendix B]).

On June 11, 1971, a leaking drum on the pavement caused the contamination of approximately 115 square feet of asphalt. Soil and approximately 200 square feet of asphalt were removed for off-site disposal. A recommendation was made to lease cargo carriers to protect the drums. A waste drum was found to be leaking shortly after that on July 2, 1971 and was determined to contain nitric acid from non-line generated waste. A rainstorm spread the contamination, affecting between 2,300 and 2,500 square feet of asphalt and gravel with levels of contamination ranging from 500 to 1,000,000 cpm plutonium. The incident prompted a request for additional cargo carriers and the use of Building 776 for storage. It was then determined that these incidents in June and July 1971 resulted in contamination of the area ranging from 100,000 to 300,000 dpm/100 cm^2 on the asphalt (Doty & Associates, 1992 [Appendix B]).

In August 1972, a punctured scrap box stored inside Building 770 contaminated 3,600 square feet inside the building and 500 square feet outside. Levels of radioactivity ranged up to 200,000 dpm/cm^2. Removal of asphalt and soil for off-site disposal began immediately following the incident.

Finally, on September 15, 1972, a 55-gallon drum containing spent ion exchange resin residue leaked inside Building 770 onto the concrete floor. Contamination was tracked between Buildings 771 and 770 and covered 600 square feet, including 50 drums and a forklift. Levels of contamination ranged from 5,000 to 100,000 cpm plutonium. The area was noted to be decontaminated, but details of these activities were not found (Doty & Associates, 1992 [Appendix B]).

The specific locations of these incidents were not recorded; however, the paved area north of Building 771 and west of Building 770 was used for storage in a structured manner since before 1969 and probably as early as 1964. The storage area was bounded on the north by a fence that was parallel to Building 771 and extended north to enclose the west entrance of Building 770. During the time of storage, the paved area still functioned as the access road for Buildings 771 and 774 (Doty & Associates, 1992 [Appendix B]).

The material stored consisted primarily of residues that had a high plutonium content and were destined for plutonium recovery operations in Building 771. Materials were stored in drums on pallets or in cargo containers. No documentation was found that provided any hazardous waste characteristics that may have been associated with the plutonium residue. Decontamination activities conducted after specific incidents would have been focused on radioactive contamination. It is likely that residual contamination from hazardous constituents may have remained (Doty & Associates, 1992 [Appendix B]).

Due to environmental concerns related to the clean-up activities at the 903 storage area and the triangle storage area, efforts were made sitewide in the early 1970s to move all radioactively-contaminated materials to indoor storage. The Building 771 area was used for storage until approximately 1974 when Building 776 was used for such storage. Building 770 was then used for the storage of equipment and also a facility for equipment assembly prior to installation in other buildings (Doty & Associates, 1992 [Appendix B]).

The results of the Radiometric Survey, performed at RFP during the late 1970s and early 1980s, indicate no extremely contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) north of Building 771 (Doty & Associates, 1992 [Appendix B]).

Information developed on this unit for the HRR indicates that the waste storage and handling also occurred west of Building 770 and possibly north of Building 774. It is proposed that the boundaries for IHSS 150.1 presented in the IAG be revised. Presently the boundaries are a 50-by 450-foot area just south of Building 770. Due to the leaking drum incident in June 1968, it is proposed that the IHSS boundary should be extended to the east approximately 120 feet. In addition, photographs clearly show that in March 1974, over 30 cargo containers were present immediately west of Building 770. The photographs also include close-up shots of the container and the ground. This area is not presently within the IHSS boundaries. Thus, extending the boundaries of IHSS 150.1 to include the area west of Building 770 has been proposed (EG&G, 1992).

2.4.18 IHSS 150.2 - Radioactive Site West of Building 771

Nature and Extent of Contamination:

On September 11, 1957, a fire was discovered in Room 108 of Building 771. Fires in the box exhaust booster filters and main filter plenum were discovered soon after. An explosion in the main exhaust duct probably contributed to the release of plutonium from the stack. The September 1957 fire in Building 771 released radioactive contamination primarily north and southwest of the building (EG&G, 1992).

During fire-fighting and decontamination activities at Building 771, access to the main filter plenum was gained through a hatchway on the west side of the building. This activity was the main cause of the spread of contamination on the west side of Building 771 at the time of the fire (EG&G, 1992).

On May 11, 1969, a fire occurred in Building 776-777. Plutonium was tracked outside of Building 776 by fire-fighting and support personnel and was detectable on the ground around the building. The tracking of contamination was confined to an area of 20 by 100 feet adjacent to the west of the building. Another source states that the contaminated area extended from the south wall of Building 778 to the north wall of the maintenance addition to Building 776 in a strip about 30 feet wide along the west wall of Building 776. Following the fire, rain carried the contamination into the soil. Airborne contamination from the May 1969 fire was carried predominantly to the west-southwest, the average wind direction at the time. Contamination was found outside the building to a maximum of 200 feet following the fire. In May 1971, a study of the steps, dock, and ramp areas on the west side of Building 776 showed radioactive contamination as high as 6,000 c/m (EG&G, 1992).

The EG&G Phase I RFI/RI Work Plan indicates that in September 1969, 320 tons of soil and asphalt containing an estimated 14 milligrams of plutonium were removed for off-site disposal.

The HRR indicates that in June 1969, an estimated 320 tons (the same amount described in the EG&G Phase I Work Plan) of asphalt and soil contaminated by plutonium at the time of the May 1969 fire were removed and buried in trenches. It is not clear, however, whether these trenches are on- or off-site.

In December 1969, contaminated soil and asphalt were removed from behind Building 776 to fill an area to the east of Building 881. In May 1971, contaminated steps and dock and ramp areas on the west side of Building 776 were covered with an epoxy paint. Areas of contamination outside Building 776 were covered with asphalt. In June 1980, contaminated asphalt was removed from the west side of building 776 and boxed as hot waste (EG&G, 1992).

2.4.19 IHSS 150.3 - Radioactive Site Between Buildings 771 and 774

Nature and Extent of Contamination

During excavation for construction between Buildings 771 and 774 in August 1971, a cement tunnel containing PWLs, which had previously been used as an exhaust ventilation duct for Building 774, was exposed. Three cracks in the concrete walls were found to be contaminated. This incident released plutonium to the soil. In September 1971, construction resulted in the exposure of the tunnel. As a result of these incidents, the cracks that were contaminated were sealed, and eight drums of soil were removed (EG&G 1992).

In December 1971 (or possibly early January 1972), construction activities in this area resulted in a broken PWL. Samples of the water showed an activity of about 1,000 pCi/l. Soil samples from the area were found to be only slightly contaminated. There is no documentation regarding further response to this incident (EG&G, 1992).

Personnel recall an incident in this area in the late 1970s or early 1980s. A flange in a line separated releasing an unspecified amount of aqueous process waste that reached the surface. Personnel recalled that the area was cleaned up (EG&G, 1992).

2.4.20 IHSS 150.4 - Radioactive Site East of Building 750

Nature and Extent of Contamination:

During excavation for construction between Buildings 771 and 774 in August 1971, a cement tunnel containing PWLs, which had previously been used as an exhaust ventilation duct for Building 774, was exposed. Three cracks in the concrete walls were found to be contaminated. This incident released plutonium contamination to the soil. In September 1971, construction excavation resulted in the exposure of the tunnel. As a result of these incidents, the cracks that were contaminated were sealed, and eight drums of soil were removed (EG&G, 1992).

In December 1971 (or possibly early January 1972), construction activities in this area resulted in a broken PWL. Samples of the water showed an activity of about 1,000 pCi/l. Soil samples from the area were found to be only slightly contaminated. There is no documentation regarding further response to this incident (EG&G,1992).

Personnel recall an incident in this area in the late 1970s or early 1980s. A flange in a line separated releasing an unspecified amount of aqueous process waste that reached the surface. Personnel recalled that the area was cleaned up (EG&G, 1992).

2.4.20 IHSS 150.4 - Radioactive Site East of Building 707

Nature and Extent of Contamination:

As discussed above, in IHSS 150.2, in May of 1969 a fire occurred in Building 776-777. Following the fire, the tanks and pumps that handled the decontamination fluid were placed into the Building 750 courtyard. This area was later paved and used for parking lots. In 1980 and 1981, there were several leaks from the manholes in these parking lots. This area is suspected to have residual contamination. No documentation is available which describes the contamination of the parking area by the decontamination tanks and pumps, nor is there a description of the several manhole leaks. The probable contaminant in this area is plutonium (EG&G, 1992).

2.4.21 IHSS 150.5 - Radioactive Site West of Building 707

Nature and Extent of Contamination:

IHSS 150.5 includes the original Valve Vault 7 location and overlies a number of active and inactive underground PWLs. All documented leaks in the area of Building 707 are related to the overflow Valve Vault 7 and the OPWL valve vault which was removed from the area in March 1973. The primary constituent released was process wastewater from the 800 and 400 areas which may contain uranium, solvents, oils, beryllium, nitric acid, hydrochloric acid, and fluoride (EG&G, 1992).

2.4.22 IHSS 150.6 - Radioactive Site South of Building 779

Nature and Extent of Contamination:

In June 1969, radioactive contamination occurred due to an improperly opened waste drum in Building 779 and was spread by pedestrian tracking to areas east and south of the building (see

also IHSS 150.8). The release consisted of radionuclides from radioactive waste. An unknown number of drums of soil were subsequently removed for off-site disposal. It is not known whether all areas affected by this incident were included in cleanup activities (EG&G, 1990).

2.4.23 IHSS 150.7 - Radioactive Site South of Building 776

Nature and Extent of Contamination:

This site, as with other IHSS 150 sites, was contaminated by the May 1969 fire which occurred in buildings 776/777 to the north of this site. Plutonium was tracked outside those buildings and onto this site by fire-fighting and support personnel and was detectable on the ground around the building. Following the fire, rain carried the contamination into the soil. The spread of contamination south of Building 776 can also be attributed to the runoff of fire water sprayed on the building to contain the fire. Sand and gravel between Building 777 and Building 778 were also contaminated before the rain. Airborne contamination from this incident was carried predominately to the west-southwest, the average wind direction at the time. Contamination was found up to 200 feet outside the building following the fire. Oil and gravel were placed over the contaminated soil as a temporary measure following the fire. The contaminated soil, oil, and gravel were removed on July 19, 1969. An asphalt roadway was completed in the area on July 22, 1969. No further documentation was found regarding response to this occurrence (EG&G, 1992).

2.4.24 IHSS 150.8 - Radioactive Site Northeast of Building 779

Nature and Extent of Contamination:

In June 1969, an improperly-opened waste drum in Building 779 radioactively contaminated areas inside and near the building. The contamination was spread by pedestrian tracking to the walkways east and south of the building as well as to the dock and adjacent ground. The release

consisted of radionuclides from radioactive waste. The contaminated soil was placed in barrels and removed for off-site disposal. It is not known whether all areas affected by this incident were included in cleanup activities (EG&G, 1992).

2.4.25 IHSS 151 - Fuel Oil Leak (Tank 262 North of Building 374)

Nature and Extent of Contamination:

The first documented spill at this site was on August 12, 1981, when about 196 gallons of No. 2 diesel fuel were spilled on the ground north of Building 374. An estimated 400 cubic yards of soil were affected by the 1981 spill (EG&G, 1992). The spill was 30 by 35 feet. A second spill released 50 gallons of No. 2 diesel fuel in July 1982. In October 1982, 120 liters were spilled. While conducting a routine system circulation of Tank 262, another spill of 10 to 20 gallons occurred in September 1988 when a vent was left open.

Reports from the 1981 incident indicated that cleanup would be initiated when the ground dried. It is documented that cleanup of the saturated soil occurred adjacent to the tank surface foundation after the 1988 spill and that the State Oil Inspector was notified. A site visit conducted for the Phase I RFI/RI indicated that only small areas of staining, 1 to 3 feet in diameter, remained around the pad, suggesting cleanup of a larger 1981 spill (EG&G, 1992).

2.4.26 IHSS 159 - Radioactive Site East of Building 559

Nature and Extent of Contamination:

Some time prior to 1970, a break in the line was discovered between Building 559 and the pump house. Reportedly, several hundred feet of contaminated soil were removed as a result of the incident. No further documentation was found regarding this pipe break (Doty & Associates, 1992 [Appendix B]).

In 1972, some time between March and May 1, the PWL ruptured near the pit, resulting in soil contamination analyzed as containing 4,500 picoCuries per gram (pCi/g) of radioactivity at the waste holding tanks, and decreasing in activity from the tanks to the concrete pad and along the south side of Building 559. The leak was discovered around May 1, 1972, when the total number of gallons of waste transferred to Building 774 was being tallied. It was then noticed that no waste had been pumped since March 22, 1972. It is estimated that approximately 4,000 gallons of waste had been released to the environment on the north side of the pit. Three breaks were found within an 8-foot area north of the pit. Reportedly, the line from the building perimeter to the holding tanks was replaced with a 4-inch PVC pipe surrounded by a 6-inch stainless-steel pipe (Doty & Associates, 1992 [Appendix B]).

A leak in the southern section of the pipeline underlying Building 559 was also found at the same time in 1972 as the leaks discussed above. The leak was located 12 inches from the south wall and 32 feet west of the east end of the tunnel (description follows). A bypass of PVC pipe was installed. Liquid was found on the floor of an air circulation tunnel, which is approximately four feet north and parallel to the pipeline. Analysis of contamination found near the floor drain indicated 20,000 to 100,000 dpm (Doty & Associates, 1992 [Appendix B]).

Another release occurred around May, 1972. Reportedly, there was a release of contaminated liquid due to the failure of a 4-inch pyrex line leading from "the surge tank to Building 774." It is unclear whether this incident involves the line exiting on the east side of Building 528 or involves the incident discussed below (Doty & Associates, 1992 [Appendix B]).

On May 2, 1977, flooding in the manhole where the two pipes leaving Building 559 join was discovered. Water samples indicated 7,000 pCi/l gross alpha on May 2, and 450 pCi/l gross alpha on May 3. Two sludge samples, collected on May 3, indicated 400 d/m/g and 45,000 d/m/g. The contamination was, at that time, thought to be due to residual groundwater contamination from the 1972 incident. The water which had collected in the manhole was pumped to the process waste holding tanks (Doty & Associates, 1992 [Appendix B]).

The manhole was observed from May 2 to May 19, and on May 19, water was found again in the manhole, as well as in the waste holding tank pit. It was determined that the leak was through the drip leg of the double-contained PWL. Approximately 4,600 gallons of water had leaked into the pit, causing the sump pumps to pump the water into the tanks, which subsequently overflowed. The water contained gross alpha of 160,000 pCi/l.[5] Conflicting documentation states that alpha activity was in excess of 300,000 disintegrations per minute per liter (d/m/l). It was concluded at that time that the process water supply line (between Buildings 559 and 561), the process line, and the shell of the PWL were broken. The pit was decontaminated, and Building 559 ceased generation of process waste water. Water samples were taken, with analyses as follows:

Date	Location	Concentration (gross alpha)
5/19/77	Process waste tank pit	160,000 pCi/l
5/20/77	Steam pit (E of where northernmost pipe exits Bldg. 559)	200 pCi/l
5/20/77	NE corner of Bldg. 561	<40 pCi/l
5/20/77	Footing drain manhole and sump between Bldgs. 559 and 561	900 pCi/l

By May 23, 1977, the concentration of gross alpha was less than 40 pCi/l at the steam pit and the northeast corner of Building 561, and 450 pCi/l at the footing drain manhole. Water was pumped from the footing drain manhole to the process waste holding tanks. No attempt was made to repair the broken line, since the new PWLs were to be ready by the week of June 13, 1977. Process waste was to be hand-carried to the tanks. Cleanup of the soil was to be completed by the end of the calendar year. At the current time process waste exits Building 528 from the southeast corner and flows to Valve Vault 10. The pipes from Building 528 to Valve Vault 10 are a two-inch and a four-inch polyethylene pipe (Doty & Associates, 1992 [Appendix B]).

Results of the analyses of core samples taken with a hand auger indicated that the contamination from leakage of the process waste beneath Building 559 was contained beneath the building. Samples from beneath the pipeline indicated activity of approximately 250 d/m/g (Doty & Associates, 1992 [Appendix B]).

As of May 26, 1972, soil had been excavated from the pit to somewhere along the length between Buildings 559 and 561, and 82 barrels of soil had been removed. Soil counts at the time indicated 10,000 counts per minute (cpm) at a 7.5-foot depth at the pit, 750 cpm 2 feet north of the pit at 92 inch depth, 300 cpm 10 feet north of the pit, 250 cpm 25 feet north of the pit, and 500 cpm 24 feet east of the concrete pad (Doty & Associates, 1992 [Appendix B]).

Following a leak near the waste storage tanks, approximately 80 drums of soil were removed. The soil waste excavated from over and around the pipeline, but not from underneath the pipeline. The strip of soil below the pipeline now lies under 7 feet of fill dirt and may contain up to 10,000 d/m/g. Reportedly, some minor surface contamination also remains (250-500 dpm), but it is mostly covered by asphalt. Documentation did not indicate whether the leak was north, west, or east of Building 528, and it is unknown whether the preceding paragraph discusses the same soil removal activities (Doty & Associates, 1992 [Appendix B]).

An August 1977 document states that removal of the contaminated soil from the flooding incident would be postponed until the fall of 1978. An October 1982 document indicates that the site had still not been cleaned up (Doty & Associates, 1992 [Appendix B]).

The Radiometric Survey performed at RFP during the late 1970s and early 1980s did not indicate any extremely-contaminated areas (stated to be 500,000 to 1,000,000 pCi/g) around Buildings 528, 559, and 561 (Doty & Associates, 1992 [Appendix B]).

Stormwater runoff in the area of Building 528 at the time of the releases and at the current time flows to the east. However, surface-water impacts could be noted to the northwest of this release

site due to the presence of footing drains in the area that may be influencing the migration of contaminants in the area. This footing drain is noted due north of Building 561. It flows to the west and combines with a 12-inch diameter corrugated metal stormwater pipe and daylights on the hillside southwest of Building 771 at approximately N37,414 and E19,961. The drainage ditch southwest of Building 771 (presumably at the combined footing drain/stormwater outfall) was sampled at the time of the May 1977 pit flooding. On May 20, 1977, the concentration of gross alpha was less than 40 pCi/l (Doty & Associates, 1992 [Appendix B]).

It is probable that the releases of process waste at this location impacted the groundwater. The presence of a footing drain in the vicinity of the releases related to this IHSS may impact groundwater flow, possibly causing a local gradient to cause contaminants related to the pipes and tanks near Building 528 to flow to the west. It appears that this footing drain is related to the underground tunnel that connects Building 559 and 561. Similarly, some migration of contaminants away from the Building 528 area could be taking place in the OPWL or in the backfill of the original PWLs that once carried process waste from the Building 528 tanks due east to the original PWL valve vault. There are presently no monitoring wells in the immediate vicinity of this IHSS (Doty & Associates, 1992 [Appendix B]).

2.4.27 IHSS 163.1 - Radioactive Site Northwest of Building 774

Nature and Extent of Contamination:

CEARP Phase I interviewees indicated the area north of Building 774 was used to wash radioactively-contaminated equipment. The wash water flowed onto the ground. Building 774 personnel did not recall this area ever being used to wash equipment (EG&G, 1992).

Aerial photos from 1969 and 1971 show two areas east of this IHSS that were covered with mounds of soil. RFP personnel interviewed did not recall these mounds (EG&G, 1992).

No radioactivity above background levels was indicated at this location by a radiological survey conducted from 1977 through 1984 (EG&G, 1992).

2.4.28 IHSS 163.2 - Radioactive Site North of Buildings 771 and 774

Nature and Extent of Contamination:

The slab was moved to a ditch directly north of the area and buried. The area was paved sometime prior to June 1969. In the mid-1970s, Building T771A, a prefabricated structure, was constructed in the same general area. None of the persons interviewed for this investigation recalled any subsequent excavation of the slab. The slab lies underground near or beneath the east end of T771A at a probable depth of less than 10 feet (Doty & Associates, 1992 [Appendix B]).

An environmental summary report from 1973 does not indicate the incident in the summary of environmental incidents impacting the soil at the RFP; however, the report does have a notation of the slab on a map of the area north of Building 771. The report indicates an area farther to the north of where the slab is believed to be buried and states that it was later excavated and the contaminated portion cut away for off-site disposal. This is not believed to be the case. The location indicated on the map cannot be accurate because it is in an area that was paved several years before the slab became contaminated. As stated above, there has been no verification that the slab was subsequently excavated (Doty & Associates, 1992 [Appendix B]).

The results of the Radiometric Survey, conducted at the RFP during the late 1970s and early 1980s, indicate no extremely-contaminated areas (stated to be 500,000 to 1,000,000 $pCi/g)^3$ north of Building 771 (Doty & Associates, 1992 [Appendix B]).

An Aerial Radiological Survey of the RFP conducted during July 1989 did not indicate anomalous concentrations of americium-241 in the area north of Building 771. However, the

survey was not structured to identify sources that occupied a small area (200 meters in diameter was the target size and less than 10 meters in diameter would not have been detected with confidence) (Doty & Associates, 1992 [Appendix B]).

The 8- by 8-foot slab is probably still buried beneath the pavement near Building T771A. There was no mention of americium-contaminated soil being buried with the slab; however, because the slab had been located on soil, it is likely that some soil from beneath the slab was also deposited when the slab was pushed into the ditch. The slab had as much contamination removed as possible and was then painted to seal the fixed contamination. Therefore, it is not likely that there is a significant amount of contaminated soil surrounding the slab. Other material of an unknown source was backfilled into the ditch prior to the area's being graded and paved (Doty & Associates, 1992 [Appendix B]).

2.4.29 IHSS 172 - Central Avenue Waste Spill

Nature and Extent of Contamination:

In June 1968, according to reference documents, one or two drums containing plutonium-tainted oil and oils with lathe coolant (70 percent hydraulic oil and 30 percent carbon tetrachloride) leaked along this path while in transit. Only the northbound and westbound lanes reportedly were affected. It was speculated that the drum(s) were punctured by a forklift while being loaded at the 903 Pad and were not noticed by workers until the vehicle had reached its destination at Building 771. Affected pavement was radioactively contaminated with levels up to 140,000 dpm/100 cm^2 (EG&G, 1990).

A former Rockwell employee recalled a number of details about this incident. The leak occurred near the end of the work day. A forklift was dispatched to transport several drums of contaminated lathe coolant on a pallet from the 903 Pad to Building 771. The drums generally were transported by truck. However, these three drums represented some of the last remaining

drums at the 903 Pad, and the small load may not have warranted a truck. Only one of the three drums leaked, and the drum released only a small portion of its contents, suggesting that the spill involved perhaps 10 gallons or less. The leak resulted from sloshing of the drum contents through an improperly sealed bung during transport. Because of this, no more material was likely to have spilled at stopping points than at other points along the route. The spill was detected when the forklift reached Building 771, and the affected roadway was quickly cordoned off. An effort was made to cleanup the spill, and the roadway was seal-coated before being reopened to RFP traffic (EG&G, 1990).

An unknown amount of "low-level material" reportedly spread to the ditch along the north side of Central Avenue as a result of this spill. Aerial photographs, taken in 1969, of RFP show that this ditch ran along essentially the entire affected length of Central Avenue. Most of the ditch has since been paved over, lined with concrete, or filled in by subsequent construction. Available references do not indicate what area(s) of the ditch received contamination. Because the release was relatively small and the cleanup response was very timely, significant contamination of the ditch is not expected (EG&G, 1990).

Most of the affected roadway has since been repaved and remains heavily used. A section of Central Avenue between Eighth and Tenth Streets was removed in August 1970 and placed in an asphalt dumping area east of Building 881. The section of Sixth Street between Sage Avenue (outside the Protected Area) and the perimeter road within the Protected Area was removed during Protected Area construction between late 1980 and late 1982. The fate of the removed asphalt is not known (EG&G, 1990).

Based upon the above information, it is recommended that IHSS 172 be redefined to exclude those portions of the roadway subsequently removed. These include Central Avenue between Eighth and Tenth Streets (approximately 1,050 ft) and Sixth Street between Sage Avenue and the Protected Area perimeter road (approximately 320 feet) (EG&G, 1990).

2.4.30 IHSS 173 - Radioactive Site - 900 Area (Storage Vaults Near Building 991)

Nature and Extent of Contamination:

Incidents involving very small quantities of plutonium, uranium, and beryllium have been noted in Building 991. The south dock of Building 991 is located on the west side of the building and is a loading facility for the tunnels. Small spills have occurred in the area. Small parts and equipment were washed in the dock area. No documentation was found detailing releases to the environment (EG&G, 1992).

According to CEARP Phase I, routine surveys of the vaults have indicated that they are free of radioactive contamination, with the exception of tunnel 996, which might be slightly uranium-infiltrated (EG&G, 1992). However, the August 1981 aerial radiological survey recorded 8,000 - 16,000 cpm of gross "man-made" radioactivity and 1,000 - 2,000 cpm of americium activity centered around Building 991 (EG&G, 1990). Final products containing plutonium and uranium were shipped from the dock, but no raw products were involved in the operations ongoing within Building 991. Acetone and perchloroethene were the solvents used within the building. No documentation was found detailing constituents which may be present in the dock area, nor was documentation available detailing responses to occurrences in the dock area (EG&G, 1992).

The IAG indicates the entire building and the area over the tunnels and vaults should be included in the IHSS primarily because of the age of the structures. The building and the vaults were used to assemble and store final products, which consisted of nickel-plated plutonium (not considered a radioactive threat). There was no documentation found indicating any contamination. It is therefore proposed that this PAC be reduced in size to the southern dock area only. Even though there was no documentation found indicating potential for contamination of this area, it is believed from interviews with retired RFP personnel involved with the activities of this area that the south dock would have a greater probability than the building or vaults of being potentially contaminated. The south half of the building was used for offices and the northern half for

laboratories and research. No documentation exists for the entire building being considered potentially contaminated (EG&G, 1992).

2.4.31 IHSS 184 - Radioactive Site - Building 992 Steam Cleaning Area

Nature and Extent of Contamination:

The Low-Priority Sites report states that this area possibly was used between 1953 and 1978 to steam clean radioactively-contaminated equipment and drums. The rinse water was collected in a sump for treatment in RFP's process waste system. Radiometric surveys have not detected radioactivity above background levels at this site (EG&G, 1990).

Building 991 personnel indicated that steam cleaning was done in an area within the southwest corner of the Building 991, not beside the guard shack or elsewhere outside the building. This was discontinued around 1969 when new cleaning facilities became available. The area was used to clean stainless-steel containers needed to ship materials to other U.S. AEC (now DOE) facilities. These containers were returned empty to Building 991 by the other facilities and were steam cleaned prior to reuse. They were screened for radioactive contamination as a shipping requirement before being returned to RFP; the steam cleaning was not intended to decontaminate the containers, only to clean them. The cleaning was done on a concrete floor which is still in place. Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building. The drain system is also still in place (EG&G, 1990).

The IAG indicates that spillage from IHSS 184 is visible on August 6, 1971 aerial photographs of the RFP. Originals of these photographs are relatively sharp but small-scale (approximately 1 in = 2,200 ft), and spillage emanating from the steam cleaning area was not identified under 10x stereoscope magnification. Small discolored areas perhaps are evident on the ground east of Building 991, but do not appear to originate at the steam cleaning area. Building 991

personnel indicated that steam cleaning was discontinued prior to the aerial photo date (EG&G, 1990).

2.4.32 IHSS 188 - Acid Leak (Southeast of Building 374)

Nature and Extent of Contamination:

IHSS 188 is an area of unspecified size southeast of Building 374. The surface was flat and unpaved at the time of the acid leak and was later paved in the mid-1980s.

The CEARP Phase I report documents a 55-gallon drum of mixed hydrochloric and nitric acids leaked near the east gate of Building 374 in 1983. The mixed acid most likely was waste metal leaching solution from the 400 complex, and might have contained very trace amounts of heavy metals. Findings from several preliminary investigations of the site have all been negative, suggesting that the acid was neutralized by the buffering action of the soil. The byproducts of the neutralization (i.e., nitrate, chloride) would be relatively benign and highly mobile in the environment (EG&G, 1990).

Recent information developed indicates that the IHSS location presented in the IAG is inaccurate. HRR information indicates that the site should be closer to Building 371 and 374 (EG&G, 1992).

There is a limited amount of available data that would assist in defining the nature and extent of contamination potentially associated with this IHSS. The nearest downgradient well, No. 1986, is located approximately 900 feet to the northeast. Due to the distance between these wells and the IHSS, the presence of other potential sources of contamination between the wells and the IHSS, and the small quantity (55 gallons maximum) of liquid released during the incident, it is improbable that any impacts attributable to this release would be detected in this well. Any residual impacts from this release would likely be confined to the immediate area of the release.

2.5 INITIAL EVALUATION

2.5.1 Summary of IHSS Conceptual Models

A conceptual model of exposure pathways was developed here for each of three IHSS groups in OU8 using the known site physical conditions and potential contaminant sources described in Sections 2.3 and 2.4. The conceptual models were developed for use in the evaluation of potential risks of OU8 contamination to human health and the environment. The IHSSs were organized into the three groups to simplify the conceptual models. The IHSSs are categorized based on contaminant source type and release mechanisms.

The three groups are as follows:

Group I - Leaks, Spills, and Overflows of Tanks and Pipelines Originating Below Ground Surface

Group II - Releases Associated with Fires and Explosions

Group III - Leaks, Spills, and Overflows of Tanks, Pipelines, and/or Drums Originating Above Ground Surface

The primary purpose of a conceptual model is to aid in identifying exposure pathways through which human and biotic receptors may be exposed to contaminants. The EPA defines an exposure pathway as "...a unique mechanism by which a population may be exposed to chemicals at or originating from the site..." (EPA, 1989a).

As shown in Figure 2-1, an exposure pathway includes a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor. An exposure pathway is not complete without each of these five components. The individual components of the exposure pathway are defined as follows:

- Contaminant Source: For purposes of the OU8 conceptual models, the contaminant source is divided into primary and secondary sources (media which that potentially been affected by these releases).

- Release Mechanism: Release mechanisms are physical and/or chemical processes through which contaminants are released or interact from one or more sources. The conceptual model identifies mechanisms that released contaminants directly from the primary sources (i.e., leaks, spills, overflows, etc.), and mechanisms that may release contaminants directly from the secondary contaminant sources.

- Transport Media: The environmental media into which contaminants are released from the source and from which contaminants are in turn released to a receptor are transport media. Potential transport media for OU8 include air, surface water, vadose zone, groundwater, and biota.

- Exposure Route: Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU8 are inhalation, ingestion, and dermal contact.

- Receptor: Receptors are human or environmental populations that may be affected by the contamination released from an IHSS or group of IHSSs. Human receptors for OU8 include RFP workers and visitors. Offsite populations are considered receptors of secondary releases carried offsite by secondary release mechanisms. Environmental receptors are biota (both flora and fauna) indigenous to the OU8 environs.

2.5.2 OU8 Generalized Conceptual Model

A diagram of the conceptual models for potential contaminant sources, transport media, exposure routes, and potential receptors relating to the OU8 IHSSs is presented in Figure 2-2. The various aspects of the conceptual model are explained in the following sections.

2.5.2.1 Contaminant Sources

The 38 IHSSs that constitute OU8 are located inside and around the Protected Area of the RFP. This area is physically enclosed with a security fence. Access is restricted to authorized personnel or visitors escorted by authorized personnel.

Contamination sources within the various IHSSs include above-ground and underground tanks, underground pipelines, equipment decontamination areas, and releases inside buildings which may

have affected areas around the buildings. Contaminants from these sources may have been introduced into the environment through spills on the ground surface, underground leakage and infiltration, explosion and/or fire, and in some cases through incident precipitation run-on and run-off. Contamination may still be entering the environment from some of the sources; in other areas, the sources may be exhausted or may have been physically mitigated through remediation at the time of the initial release.

Exclusive of volatilization to the atmosphere, the contaminants first enter the environment through the soil, and are transported by various mechanisms from affected soil to unaffected media. Therefore, for conceptual purposes, contaminated soils are considered a secondary contaminant source in each IHSS.

The chemical composition of the contaminants also varies widely between the IHSSs, ranging from low-level mixed wastes to nonradioactive organic and inorganic compounds.

In the unsaturated (vadose) zone, free liquids are expected to move generally downward to the water table, which varies in the OU8 area from a few to more than 10 feet depending upon location and time of year. If, however, the leakage or release rate exceeds the infiltration capacity of the soil, or if the surface is covered with an impermeable material (i.e., asphalt), then the liquid may pool or flow across the material surface to a more permeable material where infiltration can occur. In an instance where the release is from a pressurized source (i.e., pressurized pipeline), or the rate of leakage from an underground release exceeds the soil's infiltration capacity, the release may rise to the surface. This has occurred during a number of historical pipeline and valve vault leaks at the RFP. Liquids infiltrating the soil may also encounter a less permeable layer (low-flow boundary) and flow laterally through the more permeable soil along the boundary. At the RFP, such permeability contrasts are likely at the alluvium/bedrock contact.

Most RFP pipelines are believed to be bedded either in sand or in native soil backfill. Hydraulic conductivity in clean sand ranges from approximately 10^{-3} to 1 cm/sec. The hydraulic conductivity in the Rocky Flats Alluvium, the deposit in which the majority of RFP pipelines are located, ranges from approximately 1×10^{-2} to 7×10^{-5} cm/sec. The Valley Fill Alluvium, another common deposit at the RFP, has a hydraulic conductivity that ranges from 3×10^{-3} to 5×10^{-6} cm/sec (EG&G, 1991g). The hydraulic conductivity of unconsolidated deposits such as the Rocky Flats Alluvium is expected to increase when the deposit is disturbed (i.e., excavated and replaced as backfill material) due to increased porosity in the disturbed material.

It is therefore considered likely that most pipeline releases initially flowed preferentially through the trench materials and permeated the surrounding native soils to a much lesser extent than the trench materials. Over time, the released materials may gradually have infiltrated surrounding native soil, particularly the soil beneath the trench. Thus, contaminant plumes from pipeline releases are expected to be strongly aligned along pipeline trenches, and perhaps to extend below the trenches into underlying soils. Groundwater that may periodically or perennially saturate pipe trenches can also be expected to flow preferentially through the trench materials. Any resulting spread of contamination should remain strongly oriented along the trench.

Contaminant plumes resulting from slow, gradual pipeline leaks may be less prevalent along pipeline trenches than those from releases with higher flow rates. It is probable that many leaks occurred from the pipelines that were never detected due to low flow rate. It is also probable that some major or catastrophic releases were preceded at the same location by a longer period of slow leakage as the pipeline gradually failed. However, it is still considered likely that the relatively much higher hydraulic conductivity of the trench materials will control the orientation of contaminant plumes from gradual pipeline leaks, albeit to a lesser degree than those from more sudden releases.

Tank releases are most likely to occur at tank openings (i.e., overflows), tank/pipe connections, the base of the tank where residual waste collects, where underground tanks may be in contact

with groundwater, at cold joints along the walls of concrete tanks, and at structural beams that could be affected by differential settlement of the tank bedding or supports.

Releases from such locations would likely affect the environment immediately surrounding the tank, particularly where the release is from an underground tank bedded in backfill. Based on these conceptual tank release locations, contamination will most likely exist beneath or near external connections and openings, near joints or corners around underground tanks, and beneath the base of the tank.

Most IHSSs in OU8 overlie or are immediately adjacent to other nearby IHSSs. Thus, it may not always be possible to differentiate between contamination from specific IHSSs. Therefore, the precise extent of contamination from a given IHSS, may be difficult or impossible to determine.

2.5.2.2. Potential Transport Mechanisms and Receptors

As mentioned above, potential transport mechanisms in OU8 include air, surface water, vadose zone, and groundwater. Air pathways will be addressed by surface soil and soil gas characterization. The surface water pathway will be addressed by surface water sampling. The groundwater pathway will be addressed by subsurface soil and water sampling and hydrostratigraphic unit examination through the use of soil and bedrock boreholes and groundwater wells. Individual IHSS potential contaminant pathways may commingle with pathways from other IHSSs.

Potential contaminant receptors include RFP workers, off-site residents, and terrestrial and aquatic biota. These receptors could be exposed to OU8 contaminants through ingestion, inhalation, or dermal contact (Figure 2-2).

Air

Potential movement of contaminants by wind is possible wherever contaminated soils exist. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity. Dust-borne contaminants mobilized by wind have been documented in some areas of the RFP.

Some releases involving constituents such as volatile organic compounds (VOCs), while impacting air quality for a time near the release, typically do not spread contamination to secondary media through the air transport mechanism. However, organic vapors emanating from soils in the vadose zone can serve as an indicator of subsurface releases and potential soil contamination. The movement of organic vapors through soil is controlled by the specific properties of the contaminant and the soil as well as other physical parameters and physical characteristics of the soil.

Surface Water and Sediments

Surface soils and sediments may have been affected by releases that originated at the ground surface or releases that have surfaced from underground leaks. Precipitation runoff across these areas could then move the contamination into nearby drainages or surface impoundments. A system of collection ditches and ponds control runoff at the RFP. Some of these ditches and ponds are under investigation as separate IHSSs and sometimes separate OUs.

It is possible that surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from footing drains beneath the 700 series buildings and natural seeps.

Vadose Zone and Groundwater

Groundwater recharge from incident precipitation may occur through uncovered ground surfaces within the RFP. It is anticipated that mobile constituents of contamination in uncovered areas may eventually migrate into the vadose (unsaturated) zone, or eventually to the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP. Contaminants underlying these sources can be expected to reach the water table more quickly. Soils overlain by pavement and buildings, on the other hand, may be subject to little or no downward percolation of water, and contaminants in such soils may remain relatively immobile.

2.5.3 GROUP-SPECIFIC CONCEPTUAL MODELS

This Section presents a general summary of the OU8 characteristics by group followed by descriptions of group-specific contaminant sources, release mechanisms, transport media, exposure routes, and receptors. Section 2.5.3 is summarized in Figure 2-2. Detailed descriptions of the backgrounds and physical settings of the IHSSs making up these groups were presented in Section 2.3. Section 2.4 presented detailed information on the nature and extent of contamination specific to each IHSS.

2.5.3.1 Group I - Leaks, Spills, and Overflows of Tanks and Pipelines Originating Below Ground Surface

Most of the IHSSs in this group are associated with either the Process Waste Lines (PWLs), or the Cooling Towers. This grouping is primarily based on similar contaminant types (generally process wastes), and release mechanisms (leaks and overflows). The Original Process Wastes Lines (OPWL) system is considered a separate Operable Unit (OU9). More specific information regarding OU9 may be found in the Final Phase I RFI/RI Work Plan for OU 9 (EG&G, 1991). The specific IHSSs associated with Group I are: IHSS 118.1 - Solvent Spills (West End of Building 730), 123.1 - Valve Vault 7 (West of Building 730), 123.2 Valve Vault (West of

Building 707), IHSS 125 - 14,000 Gallon Holding Tank (Tank #66), IHSS 126.1 & 126.2 - Out-of-Service Process Waste Tanks (Building 730), IHSS 127 - Low-Level Radioactive Waste Leak, IHSS 132 - Radioactive Site - 700 Area Site #4, (Building 730), IHSS 135 - Cooling Tower Blowdown (Southeast of Building 374), IHSS 137 - Cooling Tower Blowdown (Building 774), IHSS 138 - Cooling Tower Blowdown (Building 779), IHSS 144 - Sewer Line Breaks (Building 730, Tanks 776 A-D, Leaks near Buildings 701 and 779), IHSSs 146.1 through 146.6 - Concrete Process Waste Tanks (No.s 31, 32, 34w, 34e, 30, and 33), IHSS 149 - Effluent Pipe (Southeast and North of Building 774), IHSS 150.3 - Radioactive Site (Between Buildings 771 and 774), IHSS 150.5 - Radioactive Site (West of Building 707), and IHSS 159 - Radioactive Site (East of Building 559). Figure 2-3 presents a schematic diagram of the conceptual model for Group I.

2.5.3.1.1 Contaminant Sources and Release Mechanisms

Primary Sources and Release Mechanisms

IHSS 118.1 - Solvent Spills West End of Building 730 (IAG Name: Multiple Solvent Spills West of Building 730

The primary source of contamination at IHSS 118.1 is considered to be a 5,000-gallon underground carbon tetrachloride storage tank that was located adjacent to the west side of Building 730. It is speculated that the tank or its associated pipes may have been releasing the carbon tetrachloride into the ground.

The primary release mechanisms at this IHSS are believed to be overflow and leakage. Several incidents involving leakage have been reported. In one such incident the tank failed, releasing carbon tetrachloride into the tank's sump. The sump subsequently pumped some of the liquid onto the ground surface.

IHSS 123.1 - Valve Vault 7 (Southwest of Building 707)

The primary source of contamination at IHSS 123.1 is considered to be Valve Vault 7, which is located to the southwest of Building 707, adjacent to the north side of the PA inner fence. Valve Vault 7 controls the 800 Area main PWL.

The primary release mechanism at this IHSS is a leak/overflow. A check valve in Valve Vault 7 malfunctioned allowing process wastewater to backflow into the sump. The vault filled with process wastewater and overflowed. The process wastewater drained into an adjacent storm runoff collection system ditch near Eighth Street and Sage Avenue and flowed east toward South Walnut Creek and the B-Series drainage ponds. Runoff was noticed flowing across the former 750 Parking Lot, through the Building 991 normal runoff drainage.

IHSS 123.2 - Valve Vault (West of Building 707)

The primary sources of contamination at IHSS 123.2 are considered to be a valve vault on the original process waste lines (OPWL) and pipelines either preceding or associated with this valve vault.

The primary release mechanism at this IHSS is leakage. Substantial leaks occurred at the two 45-degree elbows on this line due to expansion of the steel pipe from thermally hot steam condensate discharges from Building 881. One leak occurred in December 1958 at the south 45-degree elbow when the pipe broke and process waste followed the containment pipe to the north 45-degree elbow and leaked into a ditch. Approximately 4,050 gallons of waste leaked in this incident.

IHSS 125 - 14,000 Gallon Holding Tank (Tank #66)

The primary source of contamination at IHSS 125 is considered to be an underground concrete process waste holding tank (Tank 66) located southeast of the original Building 774.

The primary release mechanism at this IHSS is overflow. One incident that is attributed specifically to Tank 66 occurred in July 1981 when the tank overflowed and spilled an estimated 3,300 gallons of process wastewater onto the ground and pavement east of the tanks.

IHSSs 126.1 and 126.2 - Out-of-Service Process Waste Tanks (Building 728)

These two out-of-service process waste tanks are located below Building 728. Each reinforced concrete tank has a design capacity of 25,000 gallons and an approximate operating capacity of 20,000 gallons. The tanks once stored laundry water from the Building 771 laundry facility which ceased operations in the late 1950s. For this reason, they are sometimes referred to as laundry tanks. The pumphouse (Building 728) is a concrete structure situated directly above the tanks. No documents were found which identify any specific incidents of releases to the environment caused by these tanks.

The primary release mechanism at this IHSS is undetermined; however, it is suspected that if any releases have occurred, they would be due to leaks and/or overflows.

IHSS 127 - Low-Level Radioactive Waste Leak

IHSS 127 is a 20- by 100-foot area immediately west of Solar Evaporation Pond 207C. The primary source of contamination at IHSS 127 is considered to be construction activities near Building 774 and west of Solar Evaporation Pond 207C. The pipe carried aqueous waste high in nitrates with small amounts of plutonium from the process waste treatment facility to the sanitary wastewater treatment plant.

The primary release mechanism at this IHSS is leakage of a waste discharge line. The construction activities resulted in several breaks of a low-level radioactive waste discharge line.

IHSS 132 - Radioactive Site (700 Area Site #4, Building 730)

This IHSS consists of four 34-year old concrete laundry waste tanks housed inside Building 730. All four tanks are underground tanks, made of concrete with the sides poured against soils.

The primary release mechanisms associated with this IHSS are believed to be leaks and/or overflows. A slight spill onto the ground "near Building 776" was reported to have occurred during the removal of contaminated process waste sludge from the underground concrete holding tanks. The clean out of a waste tank "north of Building 776" was reported to have caused contamination to the environment which included the contamination of a cement truck. The incident involved radioactively contaminated sludge that had accumulated in the tank and was cleaned up in an undescribed manner. It is unknown if these two reports are of the same incident. RFP utilities personnel indicated that the 22,500-gallon tanks, on the south side of Building 730 were converted to catch tanks for firewater from Building 771 plenum deluge system and that the 4,500-gallon underground storage tanks on the north side were abandoned in place without decontamination. It is suspected that all four tanks are subject to groundwater infiltration and historical leakage into the soil because of their condition.

IHSS 135 - Cooling Tower Blowdown (Southeast of Building 374)

The primary source of contamination at IHSS 135 is suspected to be the Building 374 cooling tower which may have released blowdown water to the area. Blowdown water is typically routed through an underground pipe into the RFP's sanitary sewer system for treatment.

The primary release mechanism at this IHSS is unknown. No leaks or other incidents involving blowdown water from Building 374 has been documented. The only known release involved the

use of a Building 373 cooling tower pond. The cooling tower was cleaned and the slurry portion was pumped into a small retention pond. Overnight, some of the water leaked through the dirt dike and gate valve and drained into Walnut Creek.

IHSS 137 - Cooling Tower Blowdown (Building 774)

The primary source of contamination at IHSS 137 is considered to be a cooling tower (either in Building 712 or 713). It is speculated that the primary source may actually have been the Building 779 cooling tower. Cooling tower blowdown pipes leave the towers on their south sides. These pipes are considered the most probable source of any blowdown water contamination around the cooling towers.

The primary release mechanism at this IHSS was leakage. In one instance it was reported that cooling tower water was released south of Building 774 and flowed north into Walnut Creek. Another leak came from either Building 712 or Building 713. The leak has been estimated to have involved a flow rate of between 5 and 20 gallons per minute. The duration of the leak was unknown, but could have occurred several months prior to reporting.

IHSS 138 - Cooling Tower Blowdown Building 779

The primary source of contamination at IHSS 138 is considered to be an underground cooling tower water line east of Building 779. An additional source at this IHSS may also be the Building 783, #2 cooling tower.

The primary release mechanisms at this IHSS are thought to be a leak from a break in the cooling tower water line, and an overflow in the Building 783, #2 cooling tower.

IHSS 144 - Sewer Line Breaks (Building 730, Tanks 776 A-D, Leaks near Buildings 701 and 779)

The primary sources of contamination at IHSS 144 are considered to be four underground waste holding tanks located north of Building 776 and east of Building 701, in a small structure identified as Building 730. They are designated as Tanks 776 A through D. Tanks 776 A and B were laundry waste holding tanks, and Tanks 776 C and D were process waste holding tanks.

The primary release mechanisms associated with this IHSS are leaks and overflows. In 1972, increased pumping rate during a transfer of laundry waste water from Tanks 776 A and B to Building 995 caused suspension of high level sediment in the tanks and pressurization of the sanitary waste line. The pressurization of the line caused a commode and sink in Building 701 to overflow, and a patch to rupture in the line east of the waste holding tanks. Due to the overflow of the commode and sink, the toilet, sink, and floor of Building 701, as well as the ground east of the building, were contaminated. The patch which ruptured was apparently located between Buildings 777 and 779. At the time of the incident, maintenance may have been cleaning out a clean out plug near Building 701, further increasing the potential impacts on the environment.

IHSSs 146.1 through 146.6 - Concrete Process Waste Tanks

IHSS 146 represents a six-chambered reinforced concrete structure south of the original Building 774. The chambers of the structure are referred to as Tanks 30, 31, 32, 33, 34W, and 34E. Building 774, a liquid waste processing facility, has been modified several times since its construction in 1952. During the construction of a south addition in 1972, the tanks were removed.

The primary release mechanisms associated with this IHSS are leaks and overflows. The process waste tanks at Building 774 have overflowed and some of the tanks have leaked resulting in minor environmental infiltration.

IHSS 149 - Effluent Pipe (Southeast and North of Building 774)

IHSS 149 is a 20- by 550-foot area immediately north of the 207 Solar Evaporation Ponds. The area is at the crest of a hill which drops off steeply to the north and is mostly unpaved. Two 1.5-inch PVC pipes were installed to transfer wastes between Building 774 and the 207 Solar Evaporation Ponds. The one that carried low-level radioactive aqueous waste containing caustic and acids was abandoned in place in 1980.

The primary release mechanism associated with this IHSS is leakage. In one incident, a contractor broke the plastic line that ran from the evaporation ponds to Building 774. Repairs were made and the water continued to be drawn to the ponds. In another incident, a process waste line break southeast of Building 774 resulted in a release of liquid which flowed around to the front of the building. In yet another incident, a process waste line was discovered leaking southeast of Building 774. Process waste water was observed seeping up in the soil on the south side of the road southeast of Building 774. The leaking process waste water flowed down slope and through a 30-foot culvert, along the east chain-link fence and under the fence at the corner. From this point, the liquid flowed under the unpaved access road into a boggy area, the Building 771/774 Footing Drain Pond, north of Building 774. This area is not a designated wetland according to the Wetlands Assessment done for the Rocky Flats Plant (EG&G, 1990). The vegetation in the boggy area was damaged where the spilled liquid formed a pool. It was estimated that approximately 1,000 gallons had leaked from the PWL.

IHSS 150.3 - Radioactive Site Between Buildings 771 and 774 (IAG Name: Radioactive Leak Between Buildings 771 and 774)

The primary source of contamination at IHSS 150.3 is believed to be process waste lines in a cement tunnel running between Buildings 771 and 774.

The primary release mechanism at this IHSS is leakage of the PWL.

IHSS 150.5 - Radioactive Site West of Building 707 (IAG Name: Radioactive Leak West of Building 707)

The primary source of contamination at IHSS 150.5 is considered to be Valve Vault 7. IHSS 150.5 has been described as a 150- by 250-foot area southwest of Building 707. IHSS 150.5 includes the original Valve Vault 7 location and overlies a number of active and inactive underground process waste lines.

The primary release mechanisms associated with this IHSS are leaks. All documented leaks in the area of Building 707 are related to the overflow Valve Vault 7 and the original process waste line valve vault which has since been removed from the area.

IHSS 159 - Radioactive Site (East of Building 559)

The primary source of contamination at IHSS 159 is considered to be process waste lines associated with Building 559. The original construction of Building 559, the Plutonium Analytical Laboratory, included the installation of underground, pyrex, process waste lines beneath and adjacent to Building 559. Building 559 is located north of Building 561, south of Building 566, west of Building 707 and east of the Protected Area. IHSS 159, located on the east side of Building 559, is in an area of both paved and unpaved surfaces, which slopes to the east.

The primary release mechanism at this IHSS is leakage from these process waste lines. These lines have periodically broken and leaked due to settling and construction activities in the area.

Secondary Sources and Release Mechanisms

Soils have been contaminated as a result of past releases associated with the IHSSs in Group I. It is possible that sediments and groundwater have also been affected. Carbon tetrachloride, which is the contaminant involved in IHSS 118.1, has been detected in nearby wells. This

indicates that soils are very likely affected at this IHSS. In light of this, soils, sediments and groundwater should be considered as potential secondary sources within this group.

Secondary release mechanisms associated with Group I's soil contamination are considered to be leaching of contaminants from the soils and sediments by percolating groundwater, volatilization and dispersion of fugitive dust, and infiltration of contaminated groundwater.

2.5.3.1.2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group I indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-2.

Air

Air is considered a transport mechanism for Group I due to the likelihood of soils having been affected and their consideration as a secondary source. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity.

Surface Water

Surface water is known to have been affected by releases associated with some IHSSs in this group, specifically IHSSs 123.1, 123.2, 135, and 137. In addition, precipitation runoff across soils affected by Group I's IHSSs could move the contamination into nearby drainages or surface impoundments.

Surface water may also have been indirectly affected by contaminated groundwater discharging into surface water bodies such as ditches, ponds, and creeks from footing drains below the 700 series buildings and natural seeps.

Vadose Zone

The vadose zone is a potential transport media depending on the nature of the associated contaminant(s). If the contaminant is a "sinker," meaning that in its liquid state it is heavier than water, it will migrate through the vadose zone, into the water table, and to the bottom of the aquifer in question. In their vapor state, some contaminants could volatilize and rise to the ground surface.

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group I. It is possible that mobile constituents of contamination in uncovered areas eventually could leach into the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table. In addition to contaminant migration to the water table, it is possible that direct releases to groundwater have occurred at IHSSs that involve underground storage tanks. The water table at the RFP has been known to fluctuate several feet. During seasonal highs in the water table fluctuation cycle, the water table could rise above the base of the tank, making direct contamination likely.

Exposure Routes

Contaminants released from Group I IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group I IHSS localities and their environs.

2.5.3.2 Group II - Releases Associated with Fires and Explosions

IHSSs were included in this group if the releases were associated with fires or explosions in the filter system. They also have similar waste types in common (radionuclides). IHSSs associated with this group are: IHSS 150.1 - Radioactive Site (North of Building 771), IHSS 150.2 - Radioactive Site (West of Building 771), and IHSS 150.7 - Radioactive Site (South of Building 776). Figure 2-3 presents a schematic diagram of the conceptual model for Group II.

2.5.3.2.1 Contaminant Sources and Release Mechanisms

Primary Sources and Release Mechanisms

IHSS 150.1 - Radioactive Site North of Building 771 (IAG Name: Radioactive Liquid Leaks North of Building 771)

The primary sources of contamination at IHSS 150.1 are considered a fire in Building 771 and numerous releases of contaminated fluids from drums and tanks. The area is described as a 50- by 450-foot area north of Building 771. Wastes from Building 771 and materials to be

reprocessed in Building 771 where frequently handled and stored here. This area is paved, and is occupied by numerous trailers, auxiliary buildings, and storage areas. The surface was repaved 4 to 5 years ago. Prior to this the asphalt was badly deteriorated with soil exposed in many areas. Through the course of the heavy use this area received, several unrelated incidents have occurred which impacted the area.

The primary release mechanisms associated with this IHSS were ignition, spills, and leaks. The most noteworthy incidents include the following:

- In the RFP's first major fire, a plenum was breached, which released an unknown amount of radioactivity around the building, particularly to the north.
- A tank used to store concentrated americium for recovery developed a pinhole leak and dripped an unknown quantity of the americium solution onto the slab foundation.
- A drum leaked on the roadways during the removal of drums from the 903 Storage area. The forklift carrying the leaking drum traveled across the access road north of Building 771.
- Residue leaked out of a drum of filters as it was being transported from a storage area to Building 771 for processing.
- A waste drum was found to be leaking and was determined to contain nitric acid from non-line generated waste. A rainstorm spread the contamination affecting between 2,300 and 2,500 square feet of asphalt and gravel.
- A punctured scrap box stored inside Building 770 contaminated 3,600 square feet inside the building and 500 square feet outside.
- A 55-gallon drum containing spent ion exchange resin residue leaked inside Building 770 onto the concrete floor. Contamination was tracked between Buildings 771 and 770 and covered 600 square feet.

Decontamination activities conducted after specific incidents would have been focused on radioactive contamination. Residual contamination from other hazardous constituents may have remained.

IHSS 150.2 - Radioactive Site West of Building 771 (IAG Name: Radioactive Liquid Leaks West of Building 771)

The primary source of contamination at IHSS 150.2 is considered to be a fire that was discovered in Room 108 of Building 771. The fire released radioactive contamination primarily north and southwest of the building. Fires in the box exhaust booster filters and main filter plenum were discovered soon after. An explosion in the main exhaust duct probably contributed to release of plutonium from the stack.

The primary release mechanisms associated with this IHSS were volatilization, explosion, and foot traffic. During fire fighting and decontamination activities, access to the main filter plenum was gained through a hatchway on the west side of the building. This activity caused the spread of contamination on the west side of Building 771.

IHSS 150.7 - Radioactive Site South of Building 776 (IAG Name: Radioactive Liquid Leaks South of Building 776)

The primary source of contamination at IHSS 150.7 is considered to be the previously mentioned fire in Building 776-777.

The primary release mechanism at this IHSS was foot traffic. Plutonium was tracked outside those buildings, and onto this site, by fire fighting and support personnel. Following the fire, rain carried the contamination into the soil. The spread of contamination south of Building 776 can also be attributed to the runoff of fire water sprayed on the building to contain the fire. Sand and gravel between Building 777 and Building 778 were also contaminated before the rain.

Secondary Sources and Release Mechanisms

Soil was affected in the vicinity of these IHSSs as a result of spills, leaks, fallout deposition, and as a result of fire-fighting activities. Soil may have been exposed in the area directly around

Building 770 and beneath the concrete foundation slab of the americium tank. These areas have subsequently been paved. Though removal of contaminated soils was undertaken, it is likely that residual soil contamination still exists. Therefore, soils within the IHSSs associated with this group should be considered a potential secondary source.

Sediments may have been affected from contaminated fallout and from affected surface water. Sediments should also be considered a potential secondary source.

Secondary release mechanisms associated with Group II's soil contamination are considered to be leaching of contaminants from the soils and sediments by percolating groundwater, volatilization and dispersion of fugitive dust, and infiltration of contaminated groundwater.

2.5.3.2.2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group II indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-2.

Air

Movement of contaminants by wind was highly likely due to one of the primary release mechanisms being volatilization for all three IHSSs in Group II. Wind movement is also possible wherever the ground surface is affected. If the locations of these IHSSs have been covered with pavement, the likelihood of airborne contamination decreases greatly from the secondary sources.

Surface Water

Surface soils and sediments have been affected at the IHSSs in this Group. The activities associated with these IHSSs included the application of water to fight fires. Fire fighting water and precipitation runoff across these areas may have moved the contamination into the nearby drainages at the time of the incidents. Precipitation runoff subsequent to these incidents may have also moved contaminants from secondary sources to nearby drainages.

Surface water may also have been indirectly affected by contaminated groundwater discharging into surface water bodies such as ditches, ponds, and creeks from footing drains below the 700 series buildings and natural seeps.

Vadose Zone

The vadose zone is a potential transport media depending on the nature of the associated contaminant(s). If the contaminant is a "sinker," meaning that in its liquid state it is heavier than water, it will migrate through the vadose zone, into the water table, and to the bottom of the aquifer in question. In their vapor state, some contaminants could volatilize and rise to the ground surface.

Groundwater

Groundwater recharge from incident precipitation (and in this case--from fire-fighting activities) occurs through uncovered ground surfaces. All of the IHSSs associated with Group II occurred in and around uncovered ground surfaces. It is anticipated that mobile constituents of contamination in these uncovered areas have leached into the groundwater system. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no vertical infiltration of water, contaminants in such soils may remain relatively immobile.

Exposure Routes

Contaminants released from Group II IHSSs could potentially affect receptors through inhalation of airborne particles, and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group II IHSS localities and their environs.

2.5.3.3 Group III - Leaks, Spills, and Overflows of Tanks, Pipelines, and/or Drums Originating Above Ground Surface

This grouping is primarily based on similar release mechanisms. The IHSSs associated with this group are: IHSS 118.2 - Solvent Spill (South End of Building 776); IHSS 139.1(N) and (S) - Hydroxide Tank Area (Buildings 771 & 774); IHSS 139.2 - Hydrofluoric Acid Tank Area (Building 714); IHSS 150.4 - Radioactive Site (East of Building 750); IHSS 150.6 - Radioactive Site (South of Building 779); IHSS 150.8 - Radioactive Site (Northeast of Building 779); IHSS 151 -Fuel Oil Leak (Tank 262 North of Building 347); IHSS 163.1 - Radioactive Site (Northwest of Building 774); IHSS 163.2 - Radioactive Site (North of Buildings 771 & 774); IHSS 172 - Central Avenue Waste Spill; IHSS 173 - Radioactive Site - 900 Area (Storage Vaults Near Building 991); IHSS 184 - Radioactive Site - Building 992 (Steam Cleaning Area), and IHSS 188 - Acid Leak (Southeast of Building 374). Figure 2-5 presents a schematic diagram of the conceptual model for Group III.

2.5.3.3.1 Contaminant Sources and Release Mechanisms

Primary Sources and Release Mechanisms

IHSS 118.2 - Solvent Spill South End of Building 776 (IAG Name: Multiple Solvent Spills (South End of Building 776)

A 5,000-gallon above-ground carbon tetrachloride tank located within a bermed area between the north side of Building 707, and the alleyway south of Building 778 is believed to be the primary source of contamination at this site.

This tank is known to have ruptured and leaked solvent onto the ground, which contaminated the soil. An unknown amount of carbon tetrachloride was released. The tank and the area of the spill were cleaned up. No documentation was found that further details response to this occurrence.

IHSS 118.2 has been described as a 30- by 70-foot area south of Building 776. The primary source of contamination at this site is described as organic solvent tanks located inside Building 776 at the south end.

Leaks, spills, and overflows of unknown quantities are believed to have occurred from these tanks during routine filling operations.

IHSS 139.1 (N) and (S) - Hydroxide Tank Area, Buildings 771 and 774 (IAG Name: Caustic\Acid Spills)

The primary source of contamination at IHSS 139.1 is considered to be two caustic tanks, a 5,400-gallon potassium hydroxide (KOH) tank south of Building 771, and a 6,500-gallon sodium hydroxide (NaOH) tank north of Building 774. The KOH tank is located approximately 55 feet south and 35 feet east of the southeast corner of Building 771.

The primary release mechanisms at this IHSS are leaks, spills, and overflows. In several incidents spills occurred during the routine filling of the caustic tanks near Building 771. Neither the specific tanks nor the quantities involved have been thoroughly documented. In several of the instances, the spilled caustic was contained by a dike below the tank, and was not released to the environment. Some small leaks have been noted in the piping from the NaOH tank at Building 774. Some leaks that have been documented indicate seepage along the underground pipe to the outside of the building.

IHSS 139.2 - Hydrofluoric Acid Tank Area, Building 714 (IAG Name: Caustic/Acid Spills)

The primary sources of contamination at this IHSS are considered to be two horizontal, 1,300-pound hydrofluoric acid (HF) cylinders, each with a 1,200-pound capacity. They are located in Building 714, a small shed approximately 4 feet east and 29 feet south of the southeast corner of Building 771.

The primary release mechanism at this IHSS is leakage. A small vapor release from the HF connection outside Building 771 and an HF leak above Building 771 have been noted. Apparently, the hoses had collected small amounts of the acid which appeared when the line was pressurized.

IHSS 150.4 - Radioactive Site East of Building 750 (IAG Name: Radioactive Liquid Leaks East of Building 750)

The primary source of contamination and the primary release mechanism at IHSS 150.4 are unclear. IHSS 150.4 has been described as a 120- by 180-foot area northeast of Building 750. The surface is flat and mostly paved, and is used for storage, parking and loading/unloading for Building 750. The area has been paved since construction of Building 750 in 1969. In May of 1969 a fire occurred in Building 776-777. Following the fire, the tanks and pumps that handled the decontamination fluid were placed into the Building 750 courtyard. Several leaks have been noted from the manholes in this area since it was paved. This area is suspected to have residual

contamination from the storage of the decontamination equipment, however, no documentation is available that describes the contamination of the parking area by the decontamination tanks and pumps, nor is there a description of the several manhole leaks.

IHSS 150.6 - Radioactive Site South of Building 779 (IAG Name: Radioactive Liquid Leaks South of Building 779)

The primary source of contamination at IHSS 150.6 is considered to be an improperly opened waste drum in Building 779. IHSS 150.6 has been described as a 100- by 200-foot area south of Building 779. The surface is relatively flat and mostly paved.

The primary release mechanism at this IHSS is unknown (i.e., how the contamination escaped the waste drum). The contamination was spread by pedestrian tracking to areas east and south of the building (see also IHSS 150.8). An unknown number of drums of soil were subsequently removed for off-site disposal.

IHSS 150.8 - Radioactive Site Northeast of Building 779 (IAG Name: Radioactive Liquid Leaks Northeast of Building 779)

As in IHSS 150.6, the primary source of contamination at IHSS 150.8 is considered to be the improperly opened waste drum in Building 779. IHSS 150.8 has been described as an 80- by 120-foot area east of Building 779. The area is flat and includes both paved and unpaved surfaces.

Again, the primary release mechanism at this IHSS is unknown, and the contamination was spread by pedestrian tracking. The contamination was spread to the walkways east and south of the building as well as the dock and adjacent ground.

IHSS 151 - Fuel Oil Leak (Tank 262 North of Building 374)

The primary source of contamination at IHSS 151 is considered to be Tank 262, a 47,500-gallon underground storage tank. The area has been described as a 30- by 35-foot area centered over Tank 262 north of Building 374. It is overlain by a 15-by-25 foot concrete pad.

The primary release mechanisms at this IHSS are several low volume (100 gallons or less) spills of No. 2 diesel fuel.

IHSS 163.1 - Radioactive Site Northwest of Building 774 (IAG Name: Radioactive Sites #3: Wash Area)

The primary source of contamination at IHSS 163.1 is considered to be decontamination wash water. IHSS 163.1 has been described as a 60- by 150-foot area northwest of Building 774. The eastern half of the area is mostly flat and paved and is covered in part by Trailer T771G. The area was repaved 4 to 5 years ago. The western half is unpaved, slopes to the north, and is crossed by an unpaved solar evaporation ponds access road.

It is believed that the area north of Building 774 was used to wash radioactively contaminated equipment, and that the wash water flowed onto the ground. However, Building 774 personnel did not recall this area ever being used to wash equipment.

IHSS 163.2 - Radioactive Site North of Buildings 771 and 774 (IAG Name: Radioactive Sites #3: Buried Slab)

It is unknown if contaminants are being released at this site, if so the primary source of contamination is considered to be an americium-contaminated slab buried in the area near Building T771A (by the Perimeter Road). IHSS 163.2 has been described as a 50- by 50-foot area north of Buildings 771 and 774, outside the Protected Area just southeast of Parking Area #71.

The slab, which measures approximately 8-feet square and 10-inches thick, originally served as a foundation for a 5,000-gallon stainless steel tank located approximately 30 feet north of Building 771. The tank was used to store a nitrate solution high in americium with some plutonium. The slab was contaminated from a leak in the tank. When the tank was removed, the concrete slab was decontaminated until the point where smear samples did not detect further removable radioactivity. Paint was applied to the concrete to secure the fixed radioactivity. The slab was moved to a ditch directly north of the area and buried. The area has subsequently been paved. There is evidence of subsequent excavation of the slab, however, it is not conclusive.

IHSS 172 - Central Avenue Waste Spill

The primary source of contamination at IHSS 172 is considered to be a drum that was being transported from the 903 drum storage area to Building 774 (or possibly Building 771). IHSS 172 follows the path formerly used by vehicles to transport drums of waste between the 903 Pad, where the drums were stored, and the waste treatment facility in Building 771.

The primary release mechanism at this IHSS is leakage. One or two drums containing plutonium tainted oil and oils with lathe coolant (70 percent hydraulic oil and 30 percent carbon tetrachloride) leaked along this path while in transit. It was speculated that the drum(s) were punctured by a forklift while being loaded at the 903 Pad, and were not noticed by workers until the vehicle had reached its destination at Building 771. An unknown amount of "low-level material" may spread to the ditch along the north side of Central Avenue as a result of this spill.

IHSS 173 - Radioactive Site - 900 Area (Storage Vaults near Building 991)

The primary source of contamination at IHSS 173 is not specifically known. Incidents involving very small quantities of plutonium, uranium, and beryllium, have been noted in Building 991. The south dock of Building 991 is located on the west side of the building and is a loading

facility for the tunnels. This IHSS encompasses Building 991 and associated underground storage vaults (or tunnels) 996, 997, 998 and 999.

Release mechanisms are believed to be small spills that have occurred in the area and small parts and equipment decontamination in the dock area.

IHSS 184 - Radioactive Site - Building 991 Steam Cleaning Area

The primary source of contamination at IHSS 184 is considered to be steam cleaning that was done in an area within the southwest corner of the Building 991. IHSS 184 has been described as a 50- by 50-foot area near Building 992, just southwest of Building 991. It lies entirely within IHSS 173. This area possibly was used to steam clean radioactively contaminated equipment and drums. The rinse water was collected in a sump for treatment in the RFP's process waste system. The cleaning was done on a concrete floor that is still in place. Wash water ran into an outside drain which flowed south and east beneath pavement before emptying into an unlined ditch just southeast of the building. The drain system is also still in place.

IHSS 188 - Acid Leak, Southeast of Building 374

The primary source of contamination at IHSS 188 is considered to be a 55-gallon drum of mixed hydrochloric and nitric acids. IHSS 188 is an area of unspecified size southeast of Building 374. The surface was flat and unpaved at the time of the release and was later paved in the mid-1980s.

The primary release mechanism at this IHSS is leakage of the drum. The mixed acid was probably waste metal leaching solution from the 400 complex and might have contained trace amounts of heavy metals.

Secondary Sources and Release Mechanisms

Soils are known to have been contaminated as a result of past releases associated with some of the IHSSs in Group III. Though many releases that affected soils were immediately remediated, some residual contaminated soil may still be in place. It is possible that both soils and groundwater have been affected at all of the IHSSs within this group. Therefore both soils and groundwater should be considered as potential secondary sources within this group.

Surface water has been affected by releases within this group introducing the potential for sediments having been affected. Since this potential exists, sediments should also be considered as a potential secondary source.

Secondary release mechanisms associated with Group III's soil contamination are considered to be volatilization and dispersion of fugitive dust, percolation of infiltrating precipitation through contaminated soils and sediments, and movement of contaminated groundwater.

It is improbable that the spills and leaks of caustics or acids have a residual impact on the soils. Elements associated with these types of spills, such as potassium, sodium, oxygen, and hydrogen, are all naturally occurring. Therefore, they would not be indicative of the releases, except by way of concentration. Concentrations have likely decreased through dilution over time. Carbon tetrachloride, which is the contaminant involved in IHSS 118.2, has been detected in nearby wells. This indicates that soils are very likely affected at these IHSSs. It is also possible that the heavy metals associated with IHSS 188 have had a residual impact to the soils, though likely minimal. In light of these findings, the soils at some of the IHSSs within this group can be considered a potential secondary contaminant source.

2.5.3.3.2 Transport Media, Exposure Routes, and Receptors

Transport Media

Historical accounts of the IHSSs associated with Group III indicate that the releases could potentially have impacted the transport media of air, surface water, vadose zone, and groundwater through pathways illustrated in Figure 2-2.

Air

Air is considered a potential transport medium for both carbon tetrachloride and hydrofluoric acid vapors and for soils that may contain residual contamination. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction or similar activity. Air transport of vapors emanating from VOC spills, while impacting air quality for a time near the release, typically do not spread contamination to the unaffected media.

Surface Water

Surface soils, sediments, and collection ditches have been affected by releases which originated above the ground surface in Group III IHSSs. Precipitation runoff across these areas could then move the contamination into nearby drainages or surface impoundments. IHSS 173 lies within the South Walnut Creek drainage, primarily on the south-sloping north side of the drainage.

Surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from footing drains below the 700 series buildings and natural seeps.

Vadose Zone

The vadose zone is a likely transport media due to the nature of the contaminants associated with this group. No. 2 Diesel, in its vapor state, will volatilize and rise through the vadose zone to the ground surface. Carbon tetrachloride is a "sinker," which means that in its liquid state it is heavier than water and will migrate through the vadose zone, into the water table, and to the bottom of the aquifer in question. In its vapor state, it will volatilize and rise to the ground surface.

Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group III. Mobile constituents of contamination in uncovered areas may eventually leached into the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table more quickly. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water, contaminants in such soils may remain relatively immobile.

Exposure Routes

Contaminants released from Group III IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media.

Receptors

Potential human receptors include RFP workers, visitors to the site, and off-site residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group III IHSS localities and their environs.

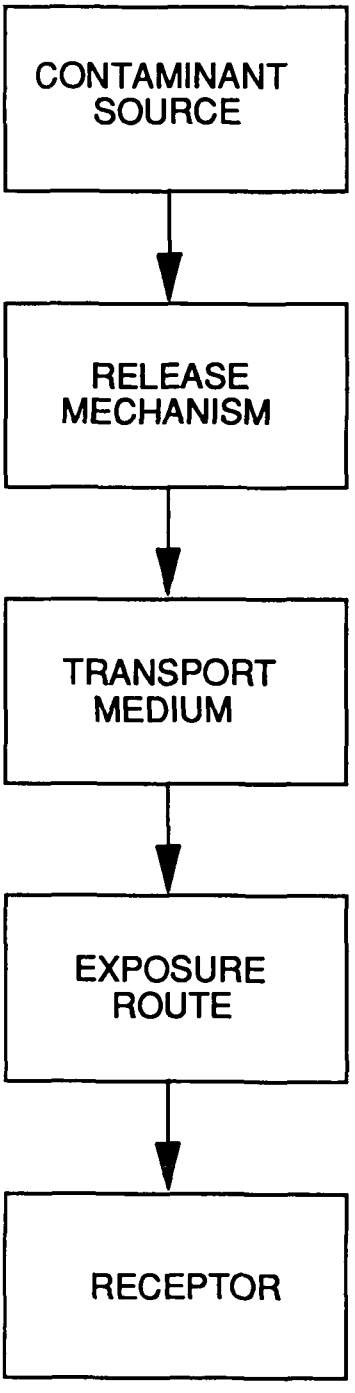


FIGURE 2-1
COMPONENTS OF A COMPLETED EXPOSURE PATHWAY

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

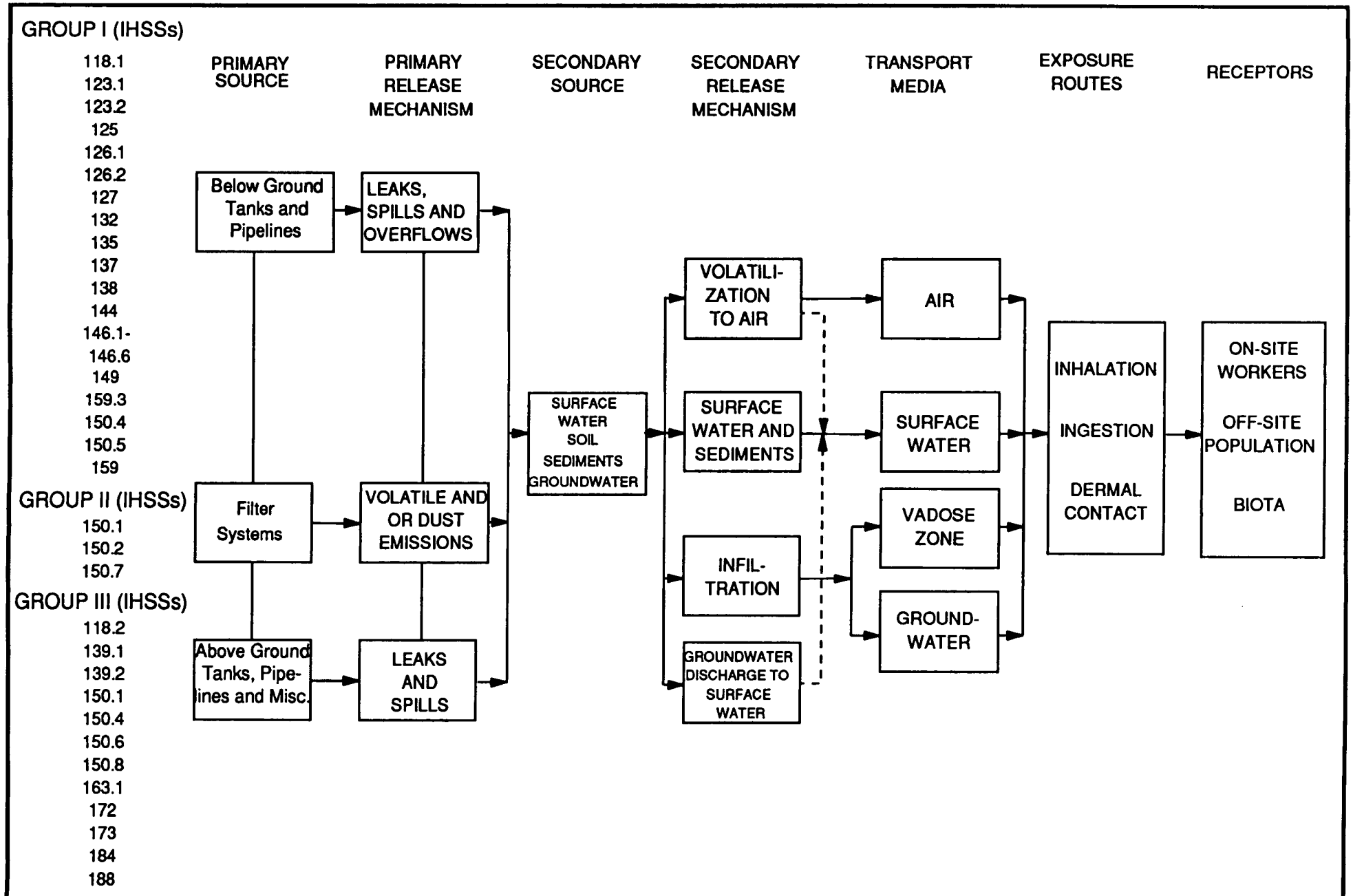


FIGURE 2-2

CONCEPTUAL MODEL FLOW CHART

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

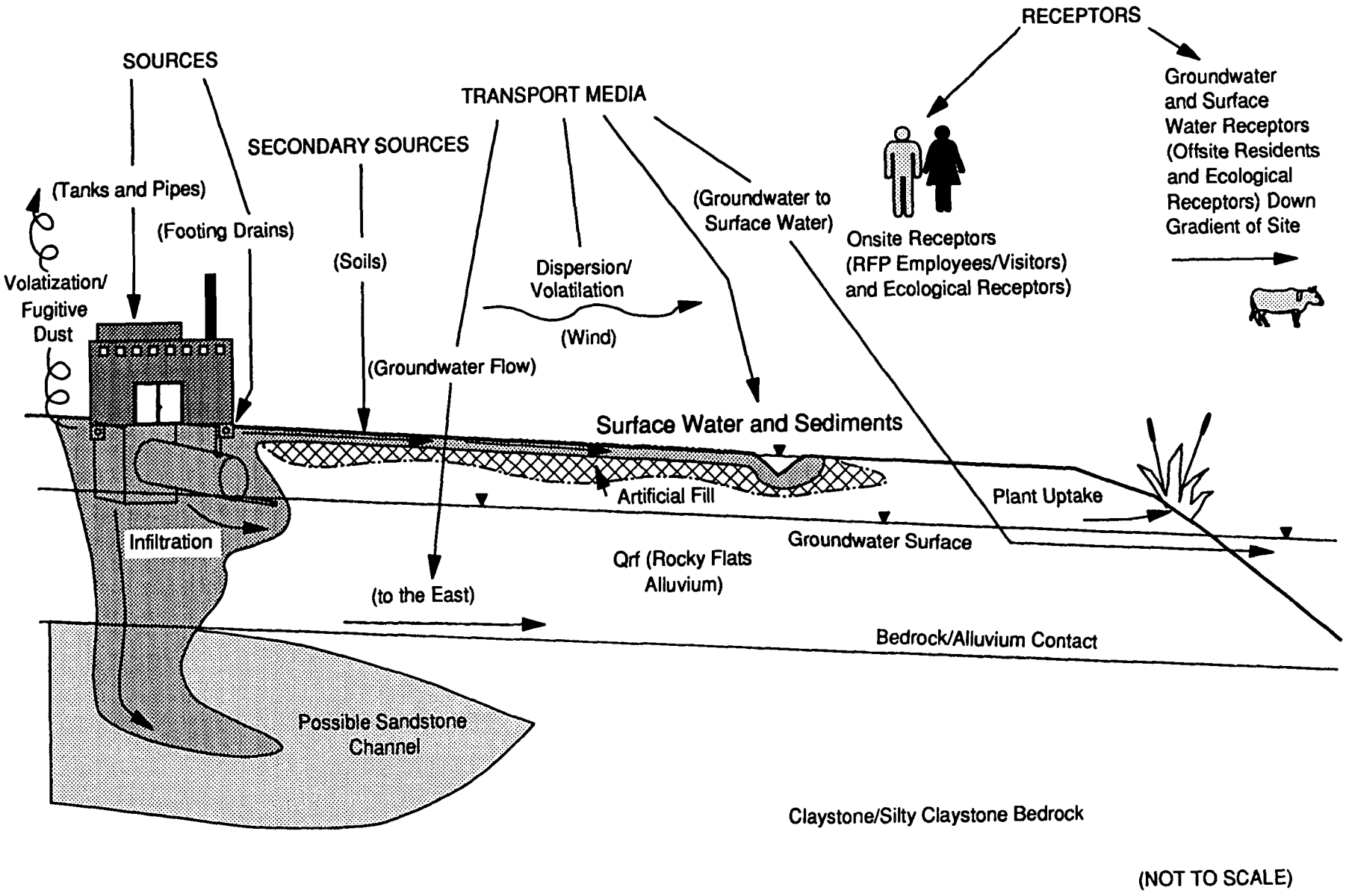


FIGURE 2-3

GROUP I - CONCEPTUAL MODEL

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

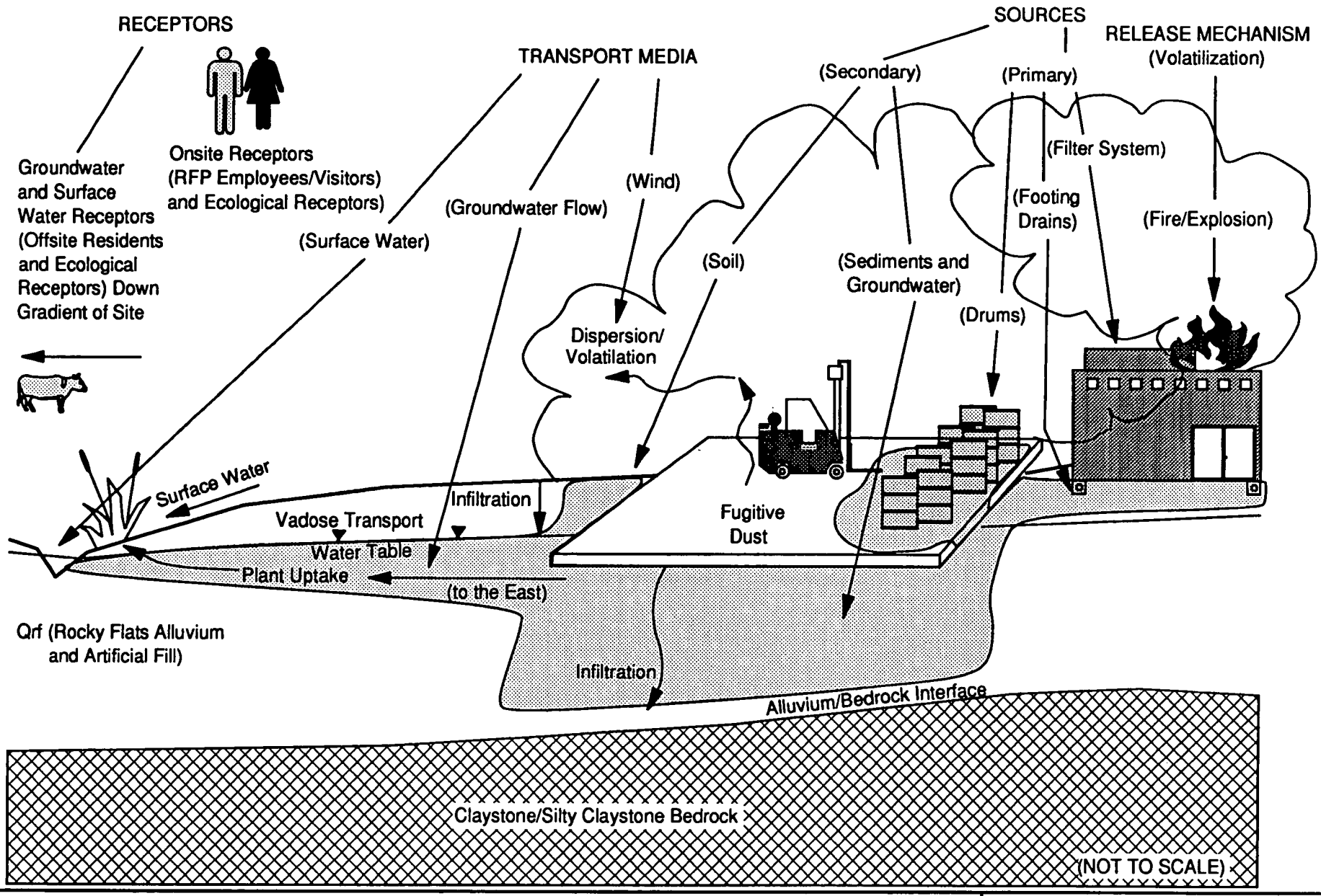


FIGURE 2-4
GROUP II - CONCEPTUAL MODEL

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

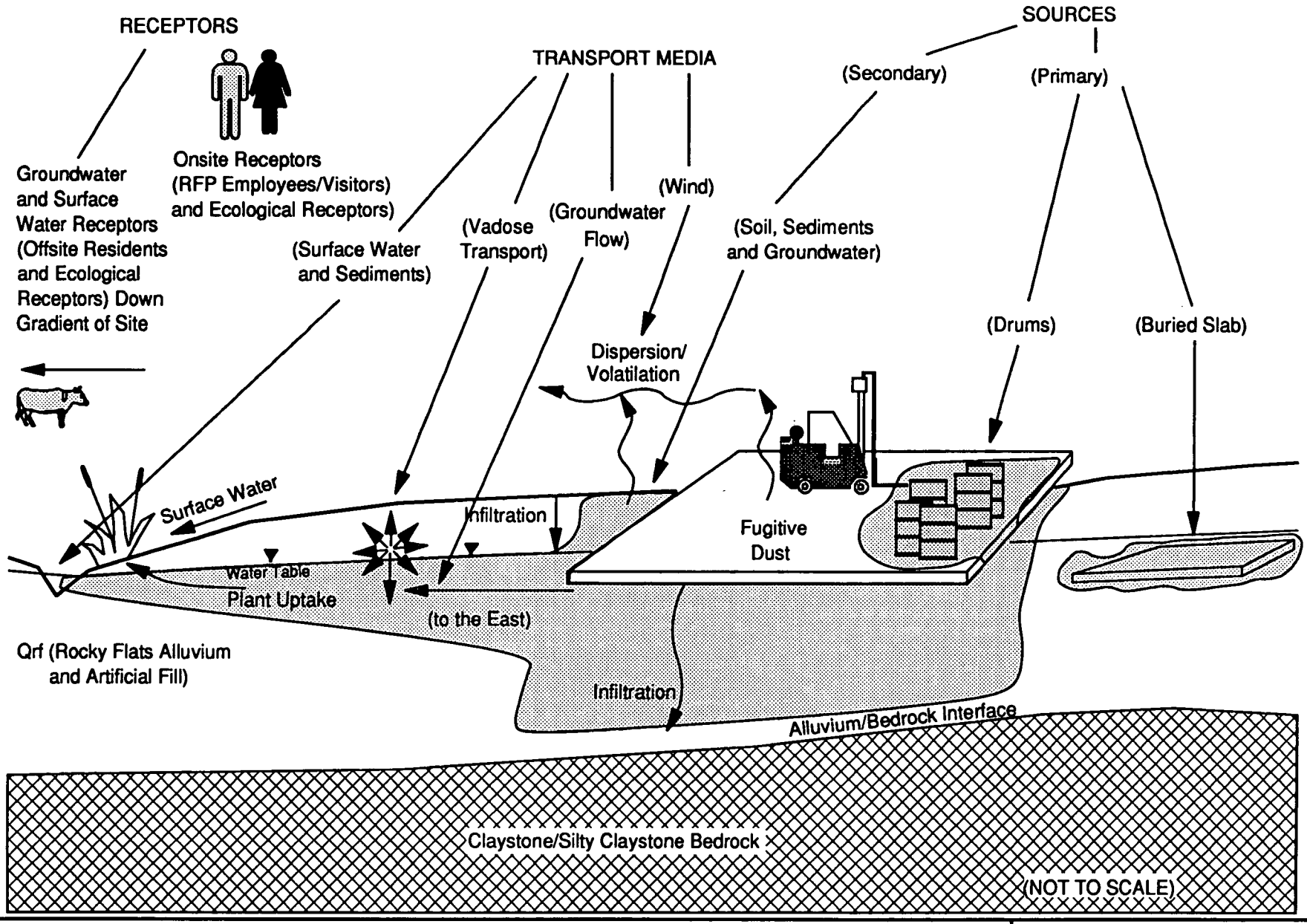


FIGURE 2-5

GROUP III - CONCEPTUAL MODEL

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

3.0 ROCKY FLATS PLANT CHEMICAL SPECIFIC BENCHMARKS

Tables 3.1 through 3.4 provide a preliminary identification of potential chemical-specific Benchmarks for groundwater and surface water at the Rocky Flats Plant. Chemical specific Benchmarks for soil have not been developed at this time. EPA analytical methods and detection limits have been specified for soil analyses to obtain data of the highest quality with the lowest possible detection limits. The Benchmarks included in this section are in lieu of ARARS, and were developed for the entire Rocky Flats Plant site and are not specific to OU8. Site-specific ARARs will be developed as the initial step of the Corrective Measures Study for OU8. As validated data become available from OU8 RFI/RI investigations, the Benchmarks will be reevaluated in accordance with Chapter Three, Part 15 of the IAG (DOE, 1991a). The site wide Benchmarks included in this work plan are not intended for use in establishing clean up goals, however, they will be used to establish RFI/RI analytical detection limits. Cleanup criteria for OU8 will be site specific and shall be based on results of an environmental and human-based Risk Assessment.

Sitewide Benchmarks represented in Tables 3.1 through 3.4 were developed from the following sources:

- Colorado Department of Health (CDH), Water Quality Control Commission (WQCC), groundwater standards (EG&G, 1991a);
- Safe Drinking Water Act (SWADA), Maximum Contaminant Levels (MCLs), surface water and groundwater (EG&G, 1991a);
- Clean Water Act (CWA), Ambient Water Quality Criteria (AWQC), potentially applicable to surface water and groundwater (EG&G, 1991a);
- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94), groundwater standards (EG&G, 1991a); and
- CDH, WQCC proposed statewide and classified groundwater area standards (EG&G, 1991a).

In instances where Benchmarks have not been proposed for a particular chemical or for a particular type of investigative method, EG&Gs General Radiochemistry and Routine Analytical Services Protocol (GRRASP) protocol or other appropriate laboratory procedures will be considered as the practical quantitation limits and will be applied (EG&G, 1991b).

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (a)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Bicarbonate	A	10,000		E310.1													
Carbonate	A	10,000		E310.1													
Chloride	A	5,000		E325	250,000 *							250,000					
Chlorine	A	1,000		E4500													
Fluoride	A	5,000		E340	4,000; 2,000*		4,000				4,000		2,000				
N as Nitrate	A	5,000		E353.1	10,000			10,000			10,000						
N as Nitrate+Nitrite	A	5,000		E353.1		10,000		10,000					100,000				
N as Nitrite	A	5,000		E354.1		1,000		1,000			1,000		10,000				
Sulfate	A	5,000		E375.4	250,000*							250,000					
Sulfide	A																
Coliform (total)	B	1		SM9221C	1/100 ml						1/100 ml						
Ammonia as N	C	5,000		E350													
Dioxin	D		0.01(9)	d						0.00000022					0.000000013		
Sulfur	E	100,000		E600													
Dissolved Oxygen	FP	500		SM4500													
pH	FP	0.1		E150.1	6.5-8.5 *							6.5-8.5	6.5-8.5				
Specific Conductance	FP	1		E120.1													
Temperature	FP																
Boron	I	5,000		E6010									750				
Total Dissolved Solids	I	10,000		E160.1	500,000*									400,000 (1)			
Aluminum	M	200		CT		50 to 200*							5,000				
Antimony	M	60		CT													
Arsenic	M	10		CT	50				50		50		100				
Arsenic III	M																
Arsenic V	M																
Barium	M	200		CT	1,000	2,000 (e)		2,000 (e)	1,000		1,000						
Beryllium	M	5		CT									100				
Cadmium	M	5		CT	10	5		5	10		10		10				
Calcium	M	5,000		CT													
Cesium	M	1,000		NC													
Chromium	M	10		CT	50	100		100	50		50		100				
Chromium III	M	5		SW8467196													
Chromium VI	M	10		E218.5													
Cobalt	M	50		CT									50				
Copper	M	25		CT	1,000 *			1,300 (f)				1,000	200				
Cyanide	M	10		CT							200						
Iron	M	100		CT	300 *							300	5,000				
Lead	M	5		CT	50			0 (f)	50		50		100				
Lithium	M	100		NC									2,500				
Magnesium	M	5000		CT													

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Link (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Women Creek	Table 6 Radionuclides Walnut Creek
Manganese	M	15		CT	50 *							50	200				
Mercury	M	0.2		CT	2	2		2	2		2		10				
Molybdenum	M	200		NC													
Nickel	M	40		CT									200				
Potassium	M	5000		CT													
Selenium	M	5		CT	10	50		50	10		10		20				
Silver	M	10		CT	50	100 *			50		50						
Sodium	M	5000		CT													
Strontium	M	200		NC													
Thallium	M	10		CT													
Tin	M	200		NC													
Titanium	M	10		E6010													
Tungsten	M	10		E6010													
Vanadium	M	50		CT									100				
Zinc	M	20		CT	5,000 *							5,000	2,000				
2,4,5-TP Silvex	P		0.5	d	10	50		50	10	50							
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P		1	d	100	70		70	100	70							
Acrolein	P		10														
Aldicarb	P		10			3 (e)		1 (e)		10							
Aldrin	P	0.05	0.1	CP						0.002					0.000074		
Bromacil	P																
Carbofuran	P			d		40		40		36							
Chloranil	P																
Chlordane (Alpha)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlordane (Gamma)	P	0.5	1	CP		2		0		0.03					0.00046		
Chlorpyrifos	P			E619													
DDT	P	0.1	0.1	CP						0.1					0.000024		
DDT Metabolite (DDD)	P	0.1		CP													
DDT Metabolite (DDE)	P	0.1	0.1	CP						0.1							
Demeton	P																
Diazinon	P																
Dieldrin	P	0.1	0.1	CP						0.002					0.000071		
Endosulfan I	P	0.05		CP													
Endosulfan II	P	0.1		CP													
Endosulfan sulfate	P	0.1		CP													
Endrin	P	0.1	0.1	CP	0.2				0.2	0.2							
Endrin Aldehyde	P		0.1							0.2							
Endrin Ketone	P	0.1		CP													
Guthion	P																
Heptachlor	P	0.05	0.05	CP		0.4		0		0.008					0.00028		
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0		0.09							

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (a)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP						0.006					0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.1(9)	CP											0.0163		
Hexachlorocyclohexane, BHC	P		0.05														
Hexachlorocyclohexane, Delta	P	0.05		CP													
Hexachlorocyclohexane, Tech	P		0.5(9)	f											0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.2		0.2	4.0	0.2					0.0186		
Malathion	P																
Methoxychlor	P	0.5	0.5	CP	100	40		40	100	40	100						
Mirex	P																
Parathion	P																
PCBs	P	0.5	1	CP		0.5		0		0.005					0.000079		
Simazine	P			e											4		
Toxaphene	P	1	5	CP		3		0	5.0	0.03	5						
Vaponite 2	P																
Aroclor 1016	PP	0.5		CP													
Aroclor 1221	PP	0.5		CP													
Aroclor 1232	PP	0.5		CP													
Aroclor 1242	PP	0.5		CP													
Aroclor 1248	PP	0.5		CP													
Aroclor 1254	PP	1		CP													
Aroclor 1260	PP	1		CP													
Atrazine	PP		1 (9)	e		3		3							3		
Americium (pCi/l)	R															0.05	0.05
Americium 241 (pCi/l)	R	0.01															
Cesium 134 (pCi/l)	R	1								80 (2)						80	80
Cesium 137 (pCi/l)	R	1															
Gross Alpha (pCi/l)	R	2			15 (8)						15(8)					7	11
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)						4 mrem/yr					5	19
Plutonium (pCi/l)	R															0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01								15 (2)							
Radium 226+228 (pCi/l)	R	0.5/1.0 (4)			5					5 (2)							
Strontium 89+90 (pCi/l)	R	1															
Strontium 90 (pCi/l)	R				8 (3)					8 (2)						8	8
Thorium 230+232 (pCi/l)	R									60 (2)							
Tritium (pCi/l)	R				20,000 (3)					20,000 (2)						500	500
Uranium 233+234 (pCi/l)	R																
Uranium 235 (pCi/l)	R	0.6															
Uranium 238 (pCi/l)	R	0.6															
Uranium (Total) (pCi/l)	R															5	10
1,2,4,5-Tetrachlorobenzene	SV		10	b						2							
1,2,4-Trichlorobenzene	SV	10		CS													

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (a)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS		600		600		620							
1,2-Diphenylhydrazine	SV			b						0.05							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS						620							
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75		75			75							
2,4,5-Trichlorophenol	SV	50		CS						700							
2,4,6-Trichlorophenol	SV	10	50	CS						2					1.2		
2,4-Dichlorophenol	SV	10	50	CS						21							
2,4-Dimethylphenol	SV	10		CS													
2,4-Dinitrophenol	SV	50	50	CS						14							
2,4-Dinitrotoluene	SV	10		CS													
2,6-Dinitrotoluene	SV	10		CS													
2-Chloronaphthalene	SV	10		CS													
2-Chlorophenol	SV	10		CS													
2-Methylnaphthalene	SV	10		CS													
2-Methylphenol	SV	10		CS													
2-Nitroaniline	SV	50		CS													
2-Nitrophenol	SV	10		CS													
3,3-Dichlorobenzidine	SV	20		CS													
3-Nitroaniline	SV	50		CS													
4,6-Dinitro-2-methylphenol	SV	50		CS													
4-Bromophenyl Phenylether	SV	10		CS													
4-Chloroaniline	SV	10		CS													
4-Chlorophenyl Phenyl Ether	SV	10		CS													
4-Chloro-3-methylphenol	SV	10		CS													
4-Methylphenol	SV	10		CS													
4-Nitroaniline	SV	50		CS													
4-Nitrophenol	SV	50		CS													
Acenaphthene	SV	10		CS													
Anthracene	SV	10		CS													
Benzidine	SV		10	d						0.0002	0.1				0.00012		
Benzoic Acid	SV	50		CS													
Benzo(a)anthracene	SV	10		CS													
Benzo(a)pyrene	SV	10		CS													
Benzo(b)fluoranthene	SV	10		CS													
Benzo(g,h,i)perylene	SV	10		CS													
Benzo(k)fluoranthene	SV	10		CS													
Benzyl Alcohol	SV	10		CS													
bis(2-Chloroethoxy)methane	SV	10		CS													
bis(2-Chloroethyl)ether	SV	10		CS						0.03					0.0000037		
bis(2-Chloroisopropyl)ether	SV	10		CS													
bis(2-Ethylhexyl)phthalate	SV	10		CS													
Butadiene	SV																
Butylbenzylphthalate	SV	10		CS													

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
		PQL MDL			SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)												Woman Creek	Walnut Creek
Chlorinated Ethers	SV																
Chlorinated Napthalenes	SV																
Chloroalkylethers	SV	10		CS													
Chlorophenol	SV										1						
Chrysene	SV	10		CS													
Dibenzofuran	SV	10		CS													
Dibenz(a,b)anthracene	SV	10		CS													
Dichlorobenzenes	SV																
Dichlorobenzidine	SV	20	10(9)	CS											0.01		
Diethylphthalate	SV	10		CS													
Dimethylphthalate	SV	10		CS													
Di-n-butylphthalate	SV	10		CS													
Di-n-octylphthalate	SV	10		CS													
Ethylene Glycol	SV			d						7,000							
Fluoranthene	SV	10		CS													
Fluorene	SV	10		CS													
Formaldehyde	SV																
Haloethers	SV																
Hexachlorobenzene	SV	10	10	CS						6					0.00072		
Hexachlorobutadiene	SV	10	10	CS						1					0.45		
Hexachlorocyclopentadiene	SV	10		CS						49							
Hexachloroethane	SV	10		CS											1.9		
Hydrazine	SV																
Indeno(1,2,3-cd)pyrene	SV	10		CS													
Isophorone	SV	10	10	CS						1,050							
Naphthalene	SV	10		CS													
Nitrobenzene	SV	10	10	CS						3.5							
Nitrophenols	SV																
Nitrosamines	SV		10														
Nitrosodibutylamine	SV			b											0.0064		
Nitrosodiethylamine	SV		10	b											0.0008		
Nitrosodimethylamine	SV		10	b											0.0014		
Nitrosopyrrolidine	SV		10	b											0.016		
N-Nitrosodiphenylamine	SV	10	10(9)	CSb											4.9		
N-Nitroso-di-n-dipropylamine	SV	10		CSb													
Pentachlorinated Ethanes	SV			b													
Pentachlorobenzene	SV		10	b						6(7)							
Pentachlorophenol	SV	50	50	CS		1(e)		0(e)		200							
Phenanthrene	SV	10		CS													
Phenol	SV	10		CS							1						
Phthalate Esters	SV																
Polynuclear Aromatic Hydrocarbons	SV		1(9)	b											0.0028		
Vinyl Chloride	SV	10	2	CV	2		0			2							

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Link (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
1,1,1-Trichloroethane	V	5	1	CV	200		200			200							
1,1,2,2-Tetrachloroethane	V	5	1 (9)	CV											0.17		
1,1,2-Trichloroethane	V	5	1	CV						3					0.6		
1,1-Dichloroethane	V	5		CV													
1,1-Dichloroethene	V	5	1	CV	7		7			7							
1,2-Dichloroethane	V	5	1	CV	5		0			0.4							
1,2-Dichloroethene (cis)	V		1	a		70		70		70							
1,2-Dichloroethene (total)	V	5		CV													
1,2-Dichloroethene (trans)	V		1	a		100		100		100							
1,2-Dichloropropane	V	5	1	CV		5		0		0.56							
1,3-Dichloropropene (cis)	V	5		CV													
1,3-Dichloropropene (trans)	V	5		CV													
2-Butanone	V	10		CV													
2-Hexanone	V	10		CV													
4-Methyl-2-pentanone	V	10		CV													
Acetone	V	10		CV													
Acrylonitrile	V		15(9)	c											0.058		
Benzene	V	5	1	CV	5		0			1							
Bromodichloromethane	V	5	1	CV						0.3							
Bromoform	V	5	1	CV						4							
Bromomethane	V	10		CV													
Carbon Disulfide	V	5		CV													
Carbon Tetrachloride	V	5	1	CV	5		0			0.3							
Chlorinated Benzenes	V	10		CV/CS													
Chlorobenzene	V	5	1	CV/CS		100		100		100							
Chloroethane	V	10		CV													
Chloroform	V	5	1	CV	Tot THM <100**					6					0.19		
Chloromethane	V	10		CV													
Dibromochloromethane	V	5	1	CV						14							
Dichloroethenes	V																
Ethyl Benzene	V	5	1	CV		700		700		680							
Ethylene Dibromide	V			d		0.05		0		0.0004							
Ethylene Oxide	V																
Halomethanes	V		1 (9)		100					100					0.19		
Methylene Chloride	V	5		CV													
Pyrene	V	10		CS													
Styrene	V	5		CV		100		100									
Tetrachloroethanes	V	5		CV													
Tetrachloroethene	V	5	1	CV		5		0		5					0.8		
Toluene	V	5	1	CV		1,000		1,000		1,000							
Trichloroethanes	V	5		CV													

TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
GROUND WATER QUALITY STANDARDS (ug/l)

					FEDERAL STANDARDS					STATE STANDARDS							
										CDH CWQCC Groundwater Quality Standards (d)							
										Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	RCRA Subpart F Limit (c)	Table A (d) (7)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Trichloroethene	V	5	1	CV	5		0			5							
Vinyl Acetate	V	10		CV													
Xylenes (total)	V	5		CV		10,000		10,000									

EXPLANATION OF TABLE

* = secondary maximum contaminant level

** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH = Colorado Department of Health
CLP = Contract Laboratory Program
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Limit
RCRA = Resource Conservation and Recovery Act
RFP = Rocky Flats Plant
SDWA = Safe Drinking Water Act
TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
CWQCC = Colorado Water Quality Control Commission

TABLE 3.2. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RPP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life(c) Acute Value	CWA AWQC for Protection of Aquatic Life(c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Bicarbonate	A	10,000		E310.1									
Carbonate	A	10,000		E310.1									
Chloride	A	5,000		E325	250,000*				860,000(e)	230,000(e)			
Chlorine	A	1,000		E4500					19	11			
Flouride	A	5,000		E340	4,000; 2,000*		4,000					4,000	
N as Nitrate	A	5,000		E353.1	10,000			10,000			10,000		
N as Nitrate+Nitrite	A	5,000		E353.1		10,000		10,000					
N as Nitrite	A	5,000		E354.1		1,000		1,000					
Sulfate	A	5,000		E375.4	250,000*								
Sulfide	A												
Coliform (Fecal)	B	1		SM9221C	1/100 ml								
Ammonia as N	C	5,000		E350					Criteria are pH and temperature dependent – see criteria document				
Dioxin	D			d					0.01	0.00001	0.000000013	0.000000014	
Sulfur	E	100,000		E600									
Dissolved Oxygen	FP	500		SM4500					5,000				
pH	FP	0.1		E150.1	6.5–8.5 *					6.5–9			
Specific Conductance	FP	1		E120.1									
Temperature	FP								SS	SS			
Boron	I	5,000		E6010									
Total Dissolved Solids	I	10,000		E160.1	500,000*				SS	SS	250,000		
Aluminum	M	200		CT		50 to 200*			750	87			
Antimony	M	60		CT					9,000	1,600	146	45,000	
Arsenic	M	10		CT	50						0.0022	0.0175	
Arsenic III	M								360	190			
Arsenic V	M								850	48			
Barium	M	200		CT	1,000	2,000(f)		2,000(f)			1,000		
Beryllium	M	5		CT					130	5.3	.0068**	.117**	
Cadmium	M	5		CT	10	5		5	3.9(3)	1.1(3)	10		
Calcium	M	5,000		CT									
Cesium	M	1,000		NC									
Chromium	M	10		CT	50	100		100					
Chromium III	M	5		SW8467196					1,700	210	170,000	3,433,000	
Chromium VI	M	10		E218.5					16	11	50		
Cobalt	M	50		CT									
Copper	M	25		CT	1,000*			1,300(g)	18(3)	12(3)			
Cyanide	M	10		CT					22	5.2	200		
Iron	M	100		CT	300 *					1,000	300		
Lead	M	5		CT	50			0(g)	82(3)	3.2(3)	50		
Lithium	M	100		NC									
Magnesium	M	5000		CT									
Manganese	M	15		CT	50*						50	100	
Mercury	M	0.2		CT	2	2		2	2.4	0.012	0.144	0.146	
Molybdenum	M	200		NC									
Nickel	M	40		CT					1,400(3)	160(3)	13.4	100	
Potassium	M	5000		CT									
Selenium	M	5		CT	10	50		50	20(d)	5(d)	10		
Silver	M	10		CT	50	100 *			4.1(3)	0.12	50		
Sodium	M	5000		CT									
Strontium	M	200		NC									
Thallium	M	10		CT					1,400(1)	40(1)	13	48	
Tin	M	200		NC									

TABLE 3.2. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (d) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (d) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Titanium	M	10		E6010									
Tungsten	M	10		E6010									
Vanadium	M	50		CT									
Zinc	M	20		CT	5,000 *				120 (3)	110 (3)			
2,4,5–TP Silvex	P		0.5	d	10	50		50					
2,4–Dichlorophenoxyacetic Acid (2,4–D)	P		1	d	100	70		70					
Acrolein	P		10						68(1)	21(1)	320	780	
Aldicarb	P		10			3 (f)		1 (f)					
Aldrin	P	0.05	0.1	CP					3.0		0.000074	0.000079	
Bromacil	P												
Carbofuran	P			d		40		40					
Chloranil													
Chlordane (Alpha)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlordane (Gamma)	P	0.5	1	CP		2		0	2.4	0.0043	0.00046	0.00048	
Chlorpyrifos	P		0.1	E619					0.063	0.041			
DDT	P	0.1	0.1	CP					1.1	0.0011	0.000024	0.000024	
DDT metabolite (DDD)	P	0.1	0.1	CP					0.06				
DDT metabolite (DDE)	P	0.1	0.1	CP					1,050				
Demeton	P		1							0.1			
Diazinon	P												
Dieldrin	P	0.1	0.1	CP					2.5	0.0019	0.00007	0.000076	
Endosulfan I	P	0.05	0.1	CP					0.22	0.056	74	159	
Endosulfan II	P	0.1	0.1	CP									
Endosulfan Sulfate	P	0.1	0.1	CP									
Endrin	P	0.1	0.1	CP	0.2				0.18	0.0023	1		
Endrin Aldehyde	P		0.1										
Endrin Ketone	P	0.1		CP									
Guthion	P		1.5							0.01			
Heptachlor	P	0.05	0.05	CP		0.4		0	0.52	0.0038	0.00028	0.00029	
Heptachlor Epoxide	P	0.05	0.05	CP		0.2		0					
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP							0.0092	0.031	
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP							0.0163	0.0547	
Hexachlorocyclohexane, BHC	P	0.05	0.05										
Hexachlorocyclohexane, Delta	P	0.05		CP									
Hexachlorocyclohexane, Technical	P		0.2	f							0.0123	0.0414	
Hexachlorocyclohexane, (Lindane) Gama	P	0.05	0.05	CP	4	0.2		0.2	2.0	0.08			
Malathion	P		0.2							0.01			
Methoxychlor	P	0.5	0.5	CP	100	40		40		0.03	100		
Mirex	P		0.1							0.001			
Parathion	P								0.065	0.013			
PCBs	P	0.5	1	CP		0.5		0	2.0	0.014	0.000079**	0.000079**	
Simazine	P			e									
Toxaphene	P	1	5	CP		3		0	0.73	0.0002	0.00071**	0.00073**	
Vaponite 2	P												
Aroclor 1016	PP	0.5		CP									
Aroclor 1221	PP	0.5		CP									
Aroclor 1232	PP	0.5		CP									
Aroclor 1242	PP	0.5		CP									
Aroclor 1248	PP	0.5		CP									
Aroclor 1254	PP	1		CP									
Aroclor 1260	PP	1		CP									
Atrazine	PP			e		3		3					

TABLE 3.2. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RPP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminan Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Americium (pCi/l)	R												
Americium 241 (pCi/l)	R	0.01											20
Cesium 134 (pCi/l)	R	1											900
Cesium 137 (pCi/l)	R	1											1000
Gross Alpha (pCi/l)	R	2			15 (10)							15	
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)								
Plutonium (pCi/l)	R												
Plutonium 238+239+240 (pCi/l)	R	0.01											20
Radium 226+228 (pCi/l)	R	0.5/0.1 (9)			5							5	60
Strontium 89+90 (pCi/l)	R	1											500
Strontium 90 (pCi/l)	R				8 (6)							8	500
Thorium 230+232 (pCi/l)	R												30
Tritium (pCi/l)	R				20,000 (6)								1000000
Uranium 233+234 (pCi/l)	R												300
Uranium 235 (pCi/l)	R	0.6											300
Uranium 238 (pCi/l)	R	0.6											300
Uranium (total) (pCi/l)	R												
1,2,4,5–Tetrachlorobenzene	SV		10	b							38	48	
1,2,4–Trichlorobenzene	SV	10		CS									
1,2–Dichlorobenzene (Ortho)	SV	10	10	CS		600		600					
1,2–Diphenylhydrazine	SV			b					270 (1)				
1,3–Dichlorobenzene (Meta)	SV	10	1	CS									
1,4–Dichlorobenzene (Para)	SV	10	1	CS	75		75						
2,4,5–Trichlorophenol	SV	50		CS							2,800		
2,4,6–Trichlorophenol	SV	10	50	CS						970 (1)	1.2 **	3.6 **	
2,4–Dichlorophenol	SV	10	50	CS					2,020 (1)	365 (1)	3,090		
2,4–Dimethylphenol	SV	10	50	CS					2,120 (1)				
2,4–Dinitrophenol	SV	50	50	CS							0.11 **	9.1 **	
2,4–Dinitrotoluene	SV	10	10	CS									
2,6–Dinitrotoluene	SV	10	10	CS					330 (1)	230 (1)	70	14,300	
2–Chloronaphthalene	SV	10		CS									
2–Chlorophenol	SV	10	so	CS					4,360 (1)	2,000 (1)			
2–Methylnaphthalene	SV	10		CS									
2–Methylphenol	SV	10		CS									
2–Nitroaniline	SV	50		CS									
2–Nitrophenol	SV	10		CS									
3,3–Dichlorobenzidine	SV	20	10	CS							0.01	0.02	
3–Nitroaniline	SV	50		CS									
4,6–Dinitro–2–methylphenol	SV	50	50	CS									
4–Bromophenyl Phenylether	SV	10		CS									
4–Chloroaniline	SV	10		CS									
4–Chlorophenyl Phenyl Ether	SV	10		CS									
4–Chloro–3–methylphenol	SV	10	50	CS					30 (1)				
4–Methylphenol	SV	10		CS									
4–Nitroaniline	SV	50		CS									
4–Nitrophenol	SV	50		CS					230 (1)	150 (1)			
Acenaphthene	SV	10	10	CS					1,700 (1)	520 (1)			
Anthracene	SV	10	1	CS									
Benzidine	SV		1	d					2,500		0.00012	0.00053	
Benzoic Acid	SV	50		CS									
Benzo(a)anthracene	SV	10	10	CS									

TABLE 3.2. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RFP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminan Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (d) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (d) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Benzo(a)pyrene	SV	10	10	CS									
Benzo(b)fluoranthene	SV	10	10	CS									
Benzo(g,h,i)perylene	SV	10	10	CS									
Benzo(k)fluoranthene	SV	10	10	CS									
Benzyl Alcohol	SV	10		CS									
bis(2–Chloroethoxy)methane	SV	10		CS									
bis(2–Chloroethyl)ether	SV	10	10	CS							0.03**	1.36 **	
bis(2–Chloroisopropyl)ether	SV	10	10	CS							34.7	4,360	
bis(2–Ethylhexyl)phthalate	SV	10	10	CS							15,000	50,000	
Butadiene	SV												
Butylbenzylphthalate	SV	10	10	CS									
Chlorinated Ethers	SV												
Chlorinated Napthalenes	SV								1,600(1)				
Chloroalkylethers	SV	10		CS					238,000(1)				
Chlorophenol	SV		50										
Chrysene	SV	10	10	CS									
Dibenzofuran	SV	10		CS									
Dibenz(a,h)anthracene	SV	10	10	CS									
Dichlorobenzenes	SV		1						1,120(1)	763(1)	400	2,600	
Dichlorobenzidine	SV	20	10	CS							0.01	0.02	
Diethylphthalate	SV	10	10	CS							350,000	1,800,000	
Dimethylphthalate	SV	10	10	CS							313,000	2,900,000	
Di–n–butylphthalate	SV	10	10	CS									
Di–n–octylphthalate	SV	10		CS									
Ethylene Glycol	SV			d									
Fluoranthene	SV	10	10	CS					3,980(1)		42	54	
Fluorene	SV	10	10	CS									
Formaldehyde	SV												
Haloethers	SV								380(1)	122(1)			
Hexachlorobenzene	SV	10	10	CS							0.00072**	0.00074**	
Hexachlorobutadiene	SV	10	10	CS					90(1)	9.3(1)	0.45**	50 **	
Hexachlorocyclopentadiene	SV	10	10	CS					7(1)	5.2(1)	206		
Hexachloroethane	SV	10	10	CS					980(1)	540(1)	1.9	8.74	
Hydrazine	SV												
Indeno(1,2,3–cd)pyrene	SV	10	10	CS									
Isophorone	SV	10	10	CS					117,000(1)		5,200	520,000	
Naphthalene	SV	10	10	CS					2,300(1)	620(1)			
Nitrobenzene	SV	10	10	CS					27,000(1)		19,800		
Nitrophenols	SV								230(1)	150(1)			
Nitrosamines	SV								5,850(1)				
Nitrosodibutylamine	SV		10	b							0.0064	0.587	
Nitrosodiethylamine	SV		10	b							0.0008	1.24	
Nitrosodimethylamine	SV		10	b							0.0014	16	
Nitrosopyrrolidine	SV		10	b							0.016	91.9	
N–Nitrosodiphenylamine	SV	10	10	b							4.9**	16.1 **	
N–Nitroso–di–n–dipropylamine	SV	10	10	b									
Pentachlorinated Ethanes	SV			b					7,240(1)	1,100(1)			
Pentachlorobenzene	SV		10	b							74	85	
Pentachlorophenol	SV	50	50	CS		1(f)		0(f)	20(4)	13(4)	1,010		
Phenanthrene	SV	10	10	CS									
Phenol	SV	10	50	CS					10,200(1)	2,560(1)	3,500		
Phthalate Esters	SV			e					940(1)	3(1)			
Polynuclear Aromatic Hydrocarbons	SV		10	b							0.0028**	0.0311**	

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RPP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (c) Fish Consumption Only	NRC Effluent Standards Water pCi/L
Vinyl Chloride	SV	10	2	CV	2		0				2 **	525 **	
1,1,1-Trichloroethane	V	5	1	CV	200		200				18,400	1,030,000	
1,1,2,2-Tetrachloroethane	V	5	1	CV						2,400	0.17**	10.7 **	
1,1,2-Trichloroethane	V	5	1	CV						9,400	0.6**	41.8 **	
1,1-Dichloroethane	V	5		CV									
1,1-Dichloroethene	V	5	1	CV	7		7						
1,2-Dichloroethane	V	5	1	CV	5		0		118,000	20,000	0.94**	243 **	
1,2-Dichloroethene (cis)	V		1	a		70		70					
1,2-Dichloroethene (total)	V	5		CV									
1,2-Dichloroethene (trans)	V	5	1	a		100		100					
1,2-Dichloropropane	V	5	1	CV		5		0	23,000	5,700			
1,3-Dichloropropene (cis)	V	5	1	CV					6,060	244 (1)	87	14,100	
1,3-Dichloropropene (trans)	V	5	1	CV					6,060	244 (1)	87	14,100	
2-Butanone	V	10		CV									
2-Hexanone	V	10		CV									
4-Methyl-2-pentanone	V	10		CV									
Acetone	V	10		CV									
Acrylonitrile	V		5	c					7,500	2,600	0.058	0.65	
Benzene	V	5	1	CV	5		0		5,300		0.66**	40 **	
Bromodichloromethane	V	5	1	CV									
Bromoform	V	5	1	CV									
Bromomethane	V	10	1	CV									
Carbon Disulfide	V	5		CV									
Carbon Tetrachloride	V	5	1	CV	5		0		35,200 (1)		0.4**	6.94 **	
Chlorinated Benzenes	V	10		CV/CS					250 (1)	50 (1)			
Chlorobenzene	V	5	1	CV/CS		100		100					
Chloroethane	V	10		CV									
Chloroform	V	5	1	CV	Tot THM < 100 (2)				28,900 (1)	1,240 (1)	0.19 **	15.7 **	
Chloromethane	V	10	1	CV									
Dibromochloromethane	V	5	1	CV									
Dichloroethenes	V		1						11,600 (1)		0.033**	1.85 **	
Ethyl Benzene	V	5	1	CV		700		700	32,000 (1)		1,400	3,280	
Ethylene Dibromide	V			d		0.05		0					
Ethylene Oxide	V												
Halomethanes	V				100				11,000 (1)		0.19**	15.7 **	
Methylene Chloride	V	5	1	CV									
Pyrene	V	10	10	CS									
Styrene	V	5		CV		100		100					
Tetrachloroethanes	V	5	1	CV					9,320 (1)				
Tetrachloroethene	V	5	1	CV		5		0	5,280 (1)	840 (1)	0.80**	8.85 **	
Toluene	V	5	1	CV		1,000		1,000	17,500 (1)		14,300	424,000	
Trichloroethanes	V	5	1	CV					18,000 (1)				
Trichloroethene	V	5	1	CV	5		0		45,000 (1)	21,900 (1)	2.7 **	80.7 **	
Vinyl Acetate	V	10		CV									
Xylenes (total)	V	5		CV		10,000		10,000					

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL RPP	PQL CDH	Method (8)	SDWA Maximum Contaminant Levels (a)	SDWA Maximum Contaminant Levels (b)	SDWA Maximum Contaminant Level Goals (a)	SDWA Maximum Contaminant Level Goals (b)	CWA AWQC for Protection of Aquatic Life (c) Acute Value	CWA AWQC for Protection of Aquatic Life (c) Chronic Value	CWA AWQC for Protection of Human Health (d) Water and Fish Ingestion	CWA AWQC for Protection of Human Health (d) Fish Consumption Only	NRC Effluent Standards Water pCi/L

EXPLANATION OF TABLE

* = secondary maximum contaminant level

** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC	= Ambient Water Quality Criteria
CLP	= Contract Laboratory Program
CWA	= Clean Water Act
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SDWA	= Safe Drinking Water Act
SS	= Species Specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(7) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(8) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TIC in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(9) MDL for radium 226 is 0.5; MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992 (56 Federal Register 3526; 1/30/1991).
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA, National Ambient Water Quality Criteria for Selenium - 1987
(e) EPA, National Ambient Water Quality Criteria for Chloride - 1988
(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 12/7/91.

TABLE 3.3. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (5)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Bicarbonate	A	10,000		E310.1										
Carbonate	A	10,000		E310.1										
Chloride	A	5,000		E325								250,000		
Chlorine	A	1,000		E4500					19	11				
Fluoride	A	5,000		E340								2,000		
N as Nitrate	A	5,000		E353.1							100,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							100,000	10,000		
N as Nitrite	A	5,000		E354.1					SS	SS	10,000	1,000		
Sulfate	A	5,000		E375.4								250,000		
Sulfide	A									2		50		
Coliform (Fecal)	B	1		SM9221C								2000/100 ml		
Ammonia as N	C	5,000		E350					620	60		500		
Dioxin	D			d	0.00000022	0.000000013	0.01	0.00001						
Sulfur	E	100,000		E600										
Dissolved Oxygen	FP	500		SM4500					5,000	5,000	3,000	3,000		
pH	FP	0.1		E150.1					6.5–9.0	6.5–9.0		5.0–9.0		
Specific Conductance	FP	1		E120.1										
Temperature	FP								30 degrees	30 degrees				
Boron	I	5,000		E6010							750			
Total Dissolved Solids	I	10,000		E160.1										
Aluminum	M	200		CT					750	87				
Antimony	M	60		CT								14		
Arsenic	M	10		CT					360	150	100	50		
Arsenic III	M													
Arsenic V	M													
Barium	M	200		CT								1,000		
Beryllium	M	5		CT							100	0.0076		
Cadmium	M	5		CT					TVS	TVS	10	10		
Calcium	M	5,000		CT										
Cesium	M	1,000		NC										
Chromium	M	10		CT										
Chromium III	M	5		SW8467196					TVS	TVS	100	50		
Chromium VI	M	10		E218.5					16	11	100	50		
Cobalt	M	50		CT										
Copper	M	25		CT					TVS	TVS	200	1,000		
Cyanide	M	10		CT					5	5	200	200		
Iron	M	100		CT						1,000		300 (dis)		
Lead	M	5		CT					TVS	TVS	100	50		
Lithium	M	100		NC										
Magnesium	M	5000		CT										
Manganese	M	15		CT						1,000	200	50 (dis)		
Mercury	M	0.2		CT					2.4	0.1		2.0		
Molybdenum	M	200		NC										
Nickel	M	40		CT					TVS	TVS	200			
Potassium	M	5000		CT										
Selenium	M	5		CT					135	17	20	10		
Silver	M	10		CT					TVS	TVS		50		
Sodium	M	5000		CT										
Strontium	M	200		NC										
Thallium	M	10		CT						15		0.012		
Tin	M	200		NC										

TABLE 3.3. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Titanium	M	10		E6010										
Tungsten	M	10		E6010										
Vanadium	M	50		CT										
Zinc	M	20		CT					TVS	TVS	2,000	5,000		
2,4,5–TP Silvex	P		0.5	d	50									
2,4–D	P		1	d	70									100
Acrolein			10			320	68	21						
Aldicarb	P		10		10									
Aldrin	P	0.05	0.1	CP	0.002(8)	0.00013	1.5						0.003	
Bromacil	P													
Carbofuran	P			d	36									
Chloranil	P			E619										
Chlordane (Alpha)	P	0.5	1	CP	0.03(8)		1.2	0.0043						
Chlordane (Gamma)	P	0.5	1	CP	0.03(8)	0.00058	1.2	0.0043						
Chlorpyrifos	P		0.1				0.083	0.041						
DDT	P	0.1	0.1	CP	0.1	0.00059	0.55	0.001					0.001	
DDT Metabolite (DDD)	P	0.1	0.1	CP		0.0008	0.6						0.001	
DDT Metabolite (DDE)	P	0.1	0.1	CP	0.1	0.00059	1,050						0.001	
Demeton	P		1					0.1					0.1	
Diazinon	P													
Dieldrin	P	0.1	0.1	CP	0.002	0.00014	1.3	0.0019					0.003	
Endosulfan I	P	0.05	0.1	CP		0.93	0.11	0.056					0.003	
Endosulfan II	P	0.1	0.1	CP										
Endosulfan Sulfate	P	0.1	0.1	CP		0.93								
Endrin	P	0.1	0.1	CP	0.2		0.09	0.0023					0.004	
Endrin Aldehyde	P		0.1		0.2	0.2								
Endrin Ketone	P	0.1		CP										
Guthion	P		1.5					0.01					0.01	
Heptachlor	P	0.05	0.05	CP	0.008	0.00021	0.26	0.0038					0.001	0.2
Heptachlor Epoxide	P	0.05	0.05	CP	0.09	0.0001	0.26	0.0038						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP	0.006		0.0039							
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.014								
Hexachlorocyclohexane, BHC	P	0.05	0.05				100							
Hexachlorocyclohexane, Delta	P	0.05		CP										
Hexachlorocyclohexane, Tech.	P		0.2	f		0.012								
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	0.2	0.019	1.0	0.08					0.01	4.0
Malathion	P		0.2					0.1					0.1	
Methoxychlor	P	0.5	0.5	CP	40			0.03					0.03	100
Mirex	P		0.1					0.001					0.001	
Parathion	P												0.04	
PCBs	P	0.5	1	CP	0.005	0.000044	2.0	0.014					0.001	
Simazine	P			e										
Toxaphene	P	1	5	CP	0.03	0.00073	0.73	0.0002					0.005	5.0
Vaponite 2	P													
Aroclor 1016	PP	0.5		CP										
Aroclor 1221	PP	0.5		CP										
Aroclor 1232	PP	0.5		CP										
Aroclor 1242	PP	0.5		CP										
Aroclor 1248	PP	0.5		CP										
Aroclor 1254	PP	1		CP										
Aroclor 1260	PP	1		CP										
Atrazine	PP			e										

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)							Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)			Organics (7)	
									Aquatic Life				
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Americium (pCi/l)	R													
Americium 241 (pCi/l)	R	0.01												
Cesium 134 (pCi/l)	R	1			80 (10)									
Cesium 137 (pCi/l)	R	1												
Gross Alpha (pCi/l)	R	2												
Gross Beta (pCi/l)	R	4												
Plutonium (pCi/l)	R													
Plutonium 238+239+240 (pCi/l)	R	0.01			15 (10)									
Radium 226+228 (pCi/l)	R	0.5/1 (9)			5 (10)									
Strontium 89+90 (pCi/l)	R	1												
Strontium 90 (pCi/l)	R				8 (10)									
Thorium 230+232 (pCi/l)	R				60 (10)									
Tritium (pCi/l)	R				20,000 (10)									
Uranium 233+234 (pCi/l)	R													
Uranium 235 (pCi/l)	R	0.6												
Uranium 238 (pCi/l)	R	0.6												
Uranium (Total) (pCi/l)	R								TVS	TVS				
1,2,4,5-Tetrachlorobenzene	SV		10	b	2 (8)									
1,2,4-Trichlorobenzene	SV	10		CS										
1,2-Dichlorobenzene (Ortho)	SV	10	1	CS	620	620								
1,2-Diphenylhydrazine	SV			b	0.05	0.04	270							
1,3-Dichlorobenzene (Meta)	SV	10	1	CS	620	400								
1,4-Dichlorobenzene (Para)	SV	10	1	CS	75	75								
2,4,5-Trichlorophenol	SV	50		CS										
2,4,6-Trichlorophenol	SV	10	50	CS	2	2		970						
2,4-Dichlorophenol	SV	10	50	CS	21	21	2,020	365						
2,4-Dimethylphenol	SV	10	50	CS			2,120							
2,4-Dinitrophenol	SV	50	50	CS	14	14								
2,4-Dinitrotoluene	SV	10	10	CS		0.11								
2,6-Dinitrotoluene	SV	10	10	CS			330	230						
2-Chloronaphthalene	SV	10		CS										
2-Chlorophenol	SV	10	50	CS			4,380	2,000						
2-Methylnaphthalene	SV	10		CS										
2-Methylphenol	SV	10		CS										
2-Nitroaniline	SV	50		CS										
2-Nitrophenol	SV	10		CS										
3,3-Dichlorobenzidine	SV	20	10	CS		0.039								
3-Nitroaniline	SV	50		CS										
4,6-Dinitro-2-methylphenol	SV	50	50	CS		13								
4-Bromophenyl Phenylether	SV	10		CS										
4-Chloroaniline	SV	10		CS										
4-Chlorophenyl Phenyl Ether	SV	10		CS										
4-Chloro-3-methylphenol	SV	10	50	CS			30							
4-Methylphenol	SV	10		CS										
4-Nitroaniline	SV	50		CS										
4-Nitrophenol	SV	50		CS										
Acenaphthene	SV	10	10	CS			1,700	520						
Anthracene	SV	10	1	CS		0.0028								
Benzidine	SV		10	d	0.0002	0.00012 (8)	2,500						0.1	0.01
Benzoic Acid	SV	50		CS										
Benzo(a)anthracene	SV	10	10	CS		0.0028								
Benzo(a)pyrene	SV	10	10	CS		0.0028								
Benzo(b)fluoranthene	SV	10	10	CS		0.0028								

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life					
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
Benzo(g,h,i)perylene	SV	10	10	CS		0.0028								
Benzo(k)fluoranthene	SV	10	10	CS		0.0028								
Benzyl Alcohol	SV	10		CS										
bis(2-Chloroethoxy) methane	SV	10		CS										
bis(2-Chloroethyl) ether	SV	10	10	CS	0.03 (8)	0.03 (8)								
bis(2-Chloroisopropyl)ether	SV	10	10	CS		1,400								
bis(2-Ethylhexyl)phthalate	SV	10	10	CS		1.8 (8)								
Butadiene	SV													
Butyl Benzylphthalate	SV	10	10	CS		3,000								
Chlorinated Ethers	SV													
Chlorinated Napthalenes	SV													
Chloroalkylethers	SV	10		CS										
Chlorophenol	SV		50										1.0	1.0
Chrysene	SV	10	10	CS		0.0028								
Dibenzofuran	SV	10		CS										
Dibenz(a,h)anthracene	SV	10	10	CS		0.0028								
Dichlorobenzenes	SV		1											
Dichlorobenzidine	SV	20	10	CS		0.039								
Diethylphthalate	SV	10	10	CS		23,000								
Dimethylphthalate	SV	10	10	CS		313,000								
Di-n-butylphthalate	SV	10	10	CS		2,700								
Di-n-octylphthalate	SV	10		CS										
Ethylene Glycol	SV			d										
Fluoranthene	SV	10	10	CS		42	3,980							
Fluorene	SV	10	10	CS		0.0028								
Formaldehyde	SV													
Haloethers	SV													
Hexachlorobenzene	SV	10	10	CS	6	0.00072								
Hexachlorobutadiene	SV	10	10	CS	1	0.45	90	9.3						
Hexachlorocyclopentadiene	SV	10	10	CS		240	7	5						
Hexachloroethane	SV	10	10	CS		1.9	980	540						
Hydrazine	SV													
Indeno(1,2,3-cd)pyrene	SV	10	10	CS		0.0028								
Isophorone	SV	10	10	CS	1,050	8.4	117,000							
Naphthalene	SV	10	10	CS		0.0028	2,300	620						
Nitrobenzene	SV	10	10	CS	3.5	3.5	27,000							
Nitrophenols	SV													
Nitrosamines	SV													
Nitrosodibutylamine	SV		10	b		0.0064								
Nitrosodiethylamine	SV		10	b		0.0008								
Nitrosodimethylamine	SV		10	b		0.00069								
Nitrosopyrrolidine	SV		10	b		0.016								
N-Nitrosodipbenylamine	SV	10	10	CSb		4.9								
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb		0.005								
Pentachlorinated Ethanes	SV			b										
Pentachlorobenzene	SV		10	b	6 (8)									
Pentachlorophenol	SV	50	50	CS	200		9	5.7						
Phenanthrene	SV	10	10	CS		0.0028								
Phenol	SV	10	50	CS		21,000	10,200	2,560					500	1.0
Phthalate Esters	SV			e										
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028								
Vinyl Chloride	SV	10	2	CV	2	2								
1,1,1-Trichloroethane	V	5	1	CV	200	200								

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Statewide Standards (a)								Basin Standards (b)	
					Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1) Aquatic Life				Organics (7)	
Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Water Supply	Water and Fish	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (4)	Aquatic Life	Water Supply
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17		2,400						
1,1,2-Trichloroethane	V	5	1	CV	3	0.6	9,400							
1,1-Dichloroethane	V	5		CV										
1,1-Dichloroethene	V	5	1	CV	7	0.057								
1,2-Dichloroethane	V	5	1	CV	0.4	0.4	118,000	20,000						
1,2-Dichloroethene (cis)	V		1	a	70									
1,2-Dichloroethene (total)	V	5		CV										
1,2-Dichloroethene (trans)	V	5	1	a	100									
1,2-Dichloropropane	V	5	1	CV	0.56 (8)	0.56	23,000	5,700						
1,3-Dichloropropene (cis)	V	5	1	CV		10	6,060	244						
1,3-Dichloropropene (trans)	V	5	1	CV		10	6,060	244						
2-Butanone	V	10		CV										
2-Hexanone	V	10		CV										
4-Methyl-2-pentanone	V	10		CV										
Acetone	V	10		CV										
Acrylonitrile	V		5	c		0.58	7,550	2,600						
Benzene	V	5	1	CV	1	1	5,300							
Bromodichloromethane	V	5	1	CV	0.3	0.3								
Bromoform	V	5	1	CV	4	4								
Bromomethane	V	10	1	CV		48								
Carbon Disulfide	V	5		CV										
Carbon Tetrachloride	V	5	1	CV	0.3	0.25	35,200							
Chlorinated Benzenes	V	10		CV/CS										
Chlorobenzene	V	5	1	CV/CVS	100	100								
Chloroethane	V	10		CV										
Chloroform	V	5	1	CV	6	6	28,900	1,240						
Chloromethane	V	10	1	CV		5.7								
Dibromochloromethane	V	5	1	CV	14	6								
Dichloroethenes	V		1											
Ethyl Benzene	V	5	1	CV	680	3,100	32,000							
Ethylene Dibromide	V			d										
Ethylene Oxide	V													
Halomethanes	V				100									
Methylene Chloride	V	5	1	CV		4.7								
Pyrene	V	10	10	CS		0.0028								
Styrene	V	5		CV										
Tetrachloroethanes	V	5	1	CV										
Tetrachloroethene	V	5	1	CV	5	0.8	5,280	840						
Toluene	V	5	1	CV	1,000	1,000	17,500							
Trichloroethanes	V	5	1	CV										
Trichloroethene	V	5	1	CV	5	2.7	45,000	21,900						
Vinyl Acetate	V	10		CV										
Xylenes (Total)	V	5		CV										

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Statewide Standards (a): Human Health Carcinogens/ Noncarcinogens (2) (8): Water Supply	Statewide Standards (a): Human Health Carcinogens/ Noncarcinogens (2) (8): Water and Fish	Statewide Standards (a): Aquatic Life (8): Acute Value	Statewide Standards (a): Aquatic Life (8): Chronic Value	Statewide Standards (a): Tables I,II,III (1): Aquatic Life: Acute Value (2)	Statewide Standards (a): Tables I,II,III (1): Aquatic Life: Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1): Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1): Domestic Water Supply (4)	Basin Standards (b): Organics (7): Aquatic Life	Basin Standards (b): Organics (7): Water Supply

EXPLANATION OF TABLE

CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(5) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV;
b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(7) See Section 3.8.5 (2)(a) in (b)
(8) Where standard is below (more stringent than) PQL (CDH), PQL is standard.
(9) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0
(10) See section 3.1.11 (f) (2) in (a)

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 10/17/1991 (ARAR).
(Environmental Reporter 726:1001-1020:6/1990)
(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990 - Basin-wide standards are ARAR.

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Bicarbonate	A	10,000		E310.1							
Carbonate	A	10,000		E310.1							
Chloride	A	5,000		E325				250,000	250,000		
Chlorine	A	1,000		E4500				3	3		
Fluoride	A	5,000		E340							
N as Nitrate	A	5,000		E353.1				10,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							
N as Nitrite	A	5,000		E354.1				1,000	1,000		
Sulfate	A	5,000		E375.4				250,000	250,000		
Sulfide	A										
Coliform (Fecal)	B	1		SM9221C							
Ammonia as N	C	5,000		E350				620	60		
Dioxin	D			d	0.00000022	0.000000013			0.000000013		
Sulfur	E	100,000		E600				2.0	2.0		
Dissolved Oxygen	FP	500		SM4500				5,000	5,000		
pH	FP	0.1		E150.1				6.5–9	6.5–9		
Specific Conductance	FP	1		E120.1							
Temperature	FP										
Boron	I	5,000		E6010				750	750		
Total Dissolved Solids	I	10,000		E160.1							
Aluminum	M	200		CT							
Antimony	M	60		CT							
Arsenic	M	10		CT				50			
Arsenic III	M										
Arsenic V	M										
Barium	M	200		CT							
Beryllium	M	5		CT							
Cadmium	M	5		CT				TVS	TVS		
Calcium	M	5,000		CT							
Cesium	M	1,000		NC							
Chromium	M	10		CT							
Chromium III	M	5		SW8467196				50			
Chromium VI	M	10		E218.5				TVS	TVS		
Cobalt	M	50		CT							
Copper	M	25		CT				TVS	TVS		
Cyanide	M	10		CT				5	5		
Iron	M	100		CT					300 (3)		
Lead	M	5		CT				TVS	TVS		
Lithium	M	100		NC							
Magnesium	M	5000		CT							
Manganese	M	15		CT					50 (3)		
Mercury	M	0.2		CT					0.01		
Molybdenum	M	200		NC							

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Nickel	M	40		CT				TVS	TVS		
Potassium	M	5000		CT							
Selenium	M	5		CT				10			
Silver	M	10		CT				TVS	TVS		
Sodium	M	5000		CT							
Strontium	M	200		NC							
Thallium	M	10		CT							
Tin	M	200		NC							
Titanium	M	10		E6010							
Tungsten	M	10		E6010							
Vanadium	M	50		CT							
Zinc	M	20		CT				TVS	TVS		
2,4,5–TP Silvex	P		0.5	d	10						
2,4–D	P		1	d	100						
Acrolein	P		10								
Aldicarb	P		10		10						
Aldrin	P	0.05	0.1	CP	0.002 (6)	0.000074			0.000074		
Bromacil	P										
Carbofuran	P			d	36						
Chloranil	P			E619							
Chlordane (Alpha)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		
Chlordane (Gamma)	P	0.5	1	CP	0.03 (6)	0.00046			0.00046		
Chlorpyrifos	P		0.1								
DDT	P	0.1	0.1	CP	0.1 (6)	0.000024			0.000024		
DDT Metabolite (DDD)	P	0.1	0.1	CP							
DDT Metabolite (DDE)	P	0.1	0.1	CP							
Demeton	P		1								
Diazinon	P										
Dieldrin	P	0.1	0.1	CP	0.002 (6)	0.000071			0.000071		
Endosulfan I	P	0.05	0.1	CP							
Endosulfan II	P	0.1	0.1	CP							
Endosulfan Sulfate	P	0.1	0.1	CP							
Endrin	P	0.1	0.1	CP	0.2						
Endrin Aldehyde	P		0.1								
Endrin Ketone	P	0.1		CP							
Guthion	P		1.5								
Heptachlor	P	0.05	0.05	CP	0.008 (6)	0.00028			0.00028		
Heptachlor Epoxide	P	0.05	0.05	CP	0.004 (6)						
Hexachlorocyclohexane, Alpha	P	0.05	0.05	CP		0.0092			0.0092		
Hexachlorocyclohexane, Beta	P	0.05	0.05	CP		0.0163			0.0163		
Hexachlorocyclohexane, BHC	P	0.05	0.05								
Hexachlorocyclohexane, Delta	P	0.05		CP							
Hexachlorocyclohexane, Tech.	P		0.2	f		0.0123			0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	0.05	CP	4	0.0186			0.0186		
Malathion	P		0.2								

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Methoxychlor	P	0.5	0.5	CP	100						
Mirex	P		0.1								
Parathion	P										
PCBs	P	0.5	1	CP	0.005 (6)	0.000079			0.000079		
Simazine	P			e		4			4		
Toxaphene	P	1	5	CP	5						
Vaponite 2	P										
Aroclor 1016	PP	0.5		CP							
Aroclor 1221	PP	0.5		CP							
Aroclor 1232	PP	0.5		CP							
Aroclor 1242	PP	0.5		CP							
Aroclor 1248	PP	0.5		CP							
Aroclor 1254	PP	1		CP							
Aroclor 1260	PP	1		CP							
Atrazine	PP			e		3			3		
Americium (pCi/l)	R									0.05	0.05
Americium 241 (pCi/l)	R	0.01					30				
Cesium 134 (pCi/l)	R	1			80		80			80	80
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2								7	11
Gross Beta (pCi/l)	R	4								5	19
Plutonium (pCi/l)	R									0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01					15				
Radium 226+228 (pCi/l)	R	0.5/1.0 (7)					5				
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R						8			8	8
Thorium 230+232 (pCi/l)	R						60				
Tritium (pCi/l)	R						20,000			500	500
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0.6									
Uranium 238 (pCi/l)	R	0.6									
Uranium (Total) (pCi/l)	R						40			5	10
1,2,4,5–Tetrachlorobenzene	SV		10	b	2 (6)						
1,2,4–Trichlorobenzene	SV	10		CS							
1,2–Dichlorobenzene (Ortho)	SV	10	1	CS	620						
1,2–Diphenylhydrazine	SV			b	0.05 (6)						
1,3–Dichlorobenzene (Meta)	SV	10	1	CS	620						
1,4–Dichlorobenzene (Para)	SV	10	1	CS	75						
2,4,5–Trichlorophenol	SV	50		CS	700						
2,4,6–Trichlorophenol	SV	10	50	CS	2.0 (6)	1.2			1.2		
2,4–Dichlorophenol	SV	10	50	CS	21 (6)						
2,4–Dimethylphenol	SV	10	50	CS							
2,4–Dinitrophenol	SV	50	50	CS							
2,4–Dinitrotoluene	SV	10	10	CS							

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
2,6-Dinitrotoluene	SV	10	10	CS							
2-Chloronaphthalene	SV	10		CS							
2-Chlorophenol	SV	10	50	CS							
2-Methylnaphthalene	SV	10		CS							
2-Methylphenol	SV	10		CS							
2-Nitroaniline	SV	50		CS							
2-Nitrophenol	SV	10		CS							
3,3-Dichlorobenzidine	SV	20	10	CS		0.01			0.01		
3-Nitroaniline	SV	50		CS							
4,6-Dinitro-2-methylphenol	SV	50	50	CS							
4-Bromophenyl Phenylether	SV	10		CS							
4-Chloroaniline	SV	10		CS							
4-Chlorophenyl Phenyl Ether	SV	10		CS							
4-Chloro-3-methylphenol	SV	10	50	CS							
4-Methylphenol	SV	10		CS							
4-Nitroaniline	SV	50		CS							
4-Nitrophenol	SV	50		CS							
Acenaphthene	SV	10	10	CS							
Anthracene	SV	10	1	CS							
Benzidine	SV		10	d	0.0002 (6)	0.00012			0.00012		
Benzoic Acid	SV	50		CS							
Benzo(a)anthracene	SV	10	10	CS							
Benzo(a)pyrene	SV	10	10	CS							
Benzo(b)fluoranthene	SV	10	10	CS							
Benzo(g,h,i)perylene	SV	10	10	CS							
Benzo(k)fluoranthene	SV	10	10	CS							
Benzyl Alcohol	SV	10		CS							
bis(2-Chloroethoxy)methane	SV	10		CS							
bis(2-Chloroethyl)ether	SV	10	10	CS	0.03 (6)	0.0000037			0.0000037		
bis(2-Chloroisopropyl)ether	SV	10	10	CS							
bis(2-Ethylhexyl)phthalate	SV	10	10	CS							
Butadiene	SV										
Butyl Benzylphthalate	SV	10		CS							
Chlorinated Ethers	SV										
Chlorinated Napthalenes	SV										
Chloroalkylethers	SV	10		CS							
Chlorophenol	SV		50								
Chrysene	SV	10	10	CS							
Dibenzofuran	SV	10		CS							
Dibenz(a,h)anthracene	SV	10	10	CS							
Dichlorobenzenes	SV		1								
Dichlorobenzidine	SV	20	10	CS		0.01			0.01		
Diethylphthalate	SV	10	10	CS							
Dimethylphthalate	SV	10	10	CS							
Di-n-butylphthalate	SV	10	10	CS							
Di-n-octylphthalate	SV	10		CS							

TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Ethylene Glycol	SV			d							
Fluoranthene	SV	10	10	CS							
Fluorene	SV	10	10	CS							
Formaldehyde	SV										
Haloethers	SV										
Hexachlorobenzene	SV	10	10	CS	0.02 (6)	0.00072			0.00072		
Hexachlorobutadiene	SV	10	10	CS	14	0.45			0.45		
Hexachlorocyclopentadiene	SV	10	10	CS	49						
Hexachloroethane	SV	10	10	CS		1.9			1.9		
Hydrazine	SV										
Indeno(1,2,3-cd)pyrene	SV	10	10	CS							
Isophorone	SV	10	10	CS	1,050						
Naphthalene	SV	10	10	CS							
Nitrobenzene	SV	10	10	CS	3.5 (6)						
Nitrophenols	SV										
Nitrosamines	SV										
Nitrosodibutylamine	SV		10	b		0.0064			0.0064		
Nitrosodiethylamine	SV		10	b		0.0008			0.0008		
Nitrosodimethylamine	SV		10	b		0.0014			0.0014		
Nitrosopyrrolidine	SV		10	b		0.016			0.016		
N-Nitrosodiphenylamine	SV	10	10	CSb		4.9			4.9		
N-Nitroso-di-n-dipropylamine	SV	10	10	CSb							
Pentachlorinated Ethanes	SV			b							
Pentachlorobenzene	SV		10	b	6 (6)						
Pentachlorophenol	SV	50	50	CS	200						
Phenanthrene	SV	10	10	CS							
Phenol	SV	10	50	CS							
Phthalate Esters	SV			e							
Polynuclear Aromatic Hydrocarbons	SV		10	b		0.0028			0.0028		
Vinyl Chloride	SV	10	2	CV	2						
1,1,1-Trichloroethane	V	5	1	CV	200						
1,1,2,2-Tetrachloroethane	V	5	1	CV		0.17			0.17		
1,1,2-Trichloroethane	V	5	1	CV	28	0.60			0.60		
1,1-Dichloroethane	V	5		CV							
1,1-Dichloroethene	V	5	1	CV	7						
1,2-Dichloroethane	V	5	1	CV	5						
1,2-Dichloroethene (cis)	V		1	a	70						
1,2-Dichloroethene (total)	V	5		CV							
1,2-Dichloroethene (trans)	V	5	1	a	70						
1,2-Dichloropropane	V	5	1	CV	0.56 (6)						
1,3-Dichloropropene (cis)	V	5	1	CV							
1,3-Dichloropropene (trans)	V	5	1	CV							
2-Butanone	V	10		CV							
2-Hexanone	V	10		CV							
4-Methyl-2-pentanone	V	10		CV							

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
		PQL MDL			Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (5)		Table 2 Radionuclides	
Parameter	Type (5)	RFP	CDH	Method (6)				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Acetone	V	10		CV							
Acrylonitrile	V		5	c		0.058			0.058		
Benzene	V	5	1	CV	5						
Bromodichloromethane	V	5	1	CV							
Bromoform	V	5	1	CV							
Bromomethane	V	10	1	CV							
Carbon Disulfide	V	5		CV							
Carbon Tetrachloride	V	1		CV	5						
Chlorinated Benzenes	V	10		CV/CS							
Chlorobenzene	V	5	1	CV/CVS	300						
Chloroethane	V	10		CV							
Chloroform	V	5	1	CV	Tot THM <100*	0.19			0.19		
Chloromethane	V	10	1	CV							
Dibromochloromethane	V	5	1	CV							
Dichloroethenes	V		1								
Ethyl Benzene	V	5	1	CV	680						
Ethylene Dibromide	V			d							
Ethylene Oxide	V										
Halomethanes	V				100	0.19			0.19		
Methylene Chloride	V	5	1	CV							
Pyrene	V	10	10	CS							
Styrene	V	5		CV							
Tetrachloroethanes	V	5	1	CV		0.8			0.8		
Tetrachloroethene	V	5	1	CV	10						
Toluene	V	5	1	CV	2,420						
Trichloroethanes	V	5	1	CV							
Trichloroethene	V	5	1	CV	5						
Vinyl Acetate	V	10		CV							
Xylenes (Total)	V	5		CV							

TABLE 3.4. POTENTIAL CHEMICAL–SPECIFIC BENCHMARKS (February 1, 1992)
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (5)	PQL MDL RFP	PQL MDL CDH	Method (6)	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4) Tables A,B (1)	Table C Fish & Water Ingestion	Table D Radio–nuclide	Stream Segment Table (5) Acute Value	Stream Segment Table (5) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek

EXPLANATION OF TABLE

•	= Total trihalomethanes:chloroform, bromoform, bromodichloromethane, dibromochloromethane
CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
RFP	= Rocky Flats Plant
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionudides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) In the absence of specific, numeric standards for non–naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/CWQCC or EPA
(2) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30–day standards, all others are 1–day standards
(3) Lowest value given: dissolved or total recoverable
(4) Segment 5 standards are goals
(5) Includes Table 1: Additional Organic Chemical Standards (chronic only)
(6) Standard is below (more stringent than) PQL, therefore PQL is standard.
(7) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002–8) 1/15/1974; amended 9/30/1989. (Envrionmental Reporter 726:1001–1020:6/1990)
(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002–8) 4/6/1981; amended 2/15/1990.

4.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTGATION TASKS

4.1 PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the 700 Area. Activities undertaken for this project have included a review of previous investigations, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which become available after preparation of this work plan. The Interagency Agreement (IAG) also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

Available aerial photographs will be reviewed again to assess the types and extent of activities at several of the IHSSs. A discussion of the aerial photograph review for each unit is included as the Step 1 work for each unit in Section 6.4.1 of this document. Available reports and plant plans will also be reviewed again. The findings of the aerial photo review and the records review will be used to finalize the field investigation program.

There are ongoing site studies at RFP of surface water and sediments, groundwater, geology, background geochemistry, and ambient air that may provide data that have bearing on the investigations in the 700 area. These data will be compiled and evaluated during the project planning activities. Data from investigations at overlapping OUs will also be reviewed. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 6.0 need not be collected again.

Other project related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPJP) and Standard Operating Procedures (SOP) for field activities, is currently being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) is included as Section 6.0 of this document. The Phase I FSP will be revised as necessary based on the findings of the photo and records review.

4.2 COMMUNITY RELATIONS

In accordance with the IAG, dated January 22, 1991, the Communications Department at Rocky Flats is developing a plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A Draft Community Relations Survey Plan has been completed and forwarded to the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the public for review. This plan specifies activities planned to complete the Environmental Restoration (ER) Program CRP, including plans for community interviews. The draft CRP was completed in September and the final CRP in November 1990, in accordance with the IAG schedules. Accordingly, a site-specific CRP is not required for Operable Unit Number 8 (OU8). The ER program community relations activities include participation by plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings of the public on proposed remedial action plans, and meetings to solicit public comment on various ER program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed on ER activities and other issues related to plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department

receives numerous public inquiries which are answered through telephone conversations or by sending written informational materials to the requestor.

4.3 FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in the 700 Area to collect samples and data concerning the nature and extent of contamination, if any, at each site. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Human Health Risk Assessment, as well as meet the objectives and data needs described in Section 5.0 of this work plan. Additional phase(s) of investigation and risk assessment may be required at IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field- investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, vadose water sampling, surface water sampling, and sediment sampling. Monitoring wells will be installed and sampled at specified locations and in some test borings.

Thirty-eight IHSSs have been included in OU8 in the 700 Area. These IHSSs have been grouped into three groups based on the contaminant source type and release mechanism of the sites. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. Specific field activities are described in the Phase I FSP in Section 6.0 of this work plan.

4.4 SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG as described in Section 6.4. Analytical procedures will be completed in

accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Section 6.0 of this work plan specifies Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPJP and the Data Validation Functional Guidelines. These documents state that the results of data review and validation activities will be documented in data validation reports.

4.5 DATA EVALUATION

Data collected during the Phase I 700 Area drainage RI will be incorporated into the existing database with data from investigations at other OUs. The data will be used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the baseline risk assessment and environmental evaluation, and to evaluate potential remedial alternatives.

4.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross sections. Geologic data will be used to evaluate the stratigraphy of the alluvium and colluvium at each site and to determine the depth to bedrock and the bedrock type.

Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigraphic characteristics of units present;
- Hydraulic gradients; and

- Water table depth and configuration.

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU8 and integrate consistently with site-wide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU8, a regional scale surface water flow and transport model will be developed. Where required, IHSS specific flow and transport models will be developed and integrated to the regional scale model.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize the 700 Area.

4.5.2 Source Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSS. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

4.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to

estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to asses the chemical concentrations are above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

4.6 PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU8 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in five general steps:

- Identification of chemicals of concern;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Presentation of uncertainties and limitations of the analysis.

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Human Health Risk Assessment Plan for OU8, Section 8.0 of this work plan. The Environmental Evaluation Work Plan for OU8 is Section 9.0 of this work plan.

4.7 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

Remedial action alternatives reflect remedial action objectives aimed at protecting human health and the environment and should specify contaminants, exposure routes and receptors, and a preliminary remediation goal (e.g., an acceptable contaminant range).

4.7.1 Surficial Materials, Bedrock, Surface Water and Sediments, and Groundwater

4.7.1.1 Development and Screening of Remedial Alternatives

This section identifies potential technologies applicable to remediation of contaminated soils, bedrock, surface water, surficial materials, and groundwater at OU8. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies and assembling an initial screening of alternatives will be conducted simultaneously with the RFI/RI. However, investigation of this OU is in its early stages; thus, remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives for OU8 will be addressed in the feasibility study (FS).

OU8 is a CERCLA unit and as such the processes employed to develop and evaluate alternatives for OU8 are outlined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988). As stated in the IAG, general compliance with both RCRA and CERCLA is required for this OU. However, the outline presented in the CERCLA Guidelines provides the greatest detail and ensures compliance with RCRA.

The following steps were used to develop remedial alternatives for the OU8 area:

- Develop remedial action objectives of a general nature appropriate for site-specific, risk-related factors and based on chemical-specific and radionuclide-specific standards when available.
- Develop a list of actions appropriate for the bedrock, surface water, surficial materials, and groundwater at OU8 (such as containment, treatment, and/or

removal) that may be implemented to satisfy the objectives defined in the previous step. These actions are generally referred to as "general response actions" in EPA guidelines.

- Identify and screen technology groups for each general response action. General response actions can each be further defined to include groups of technologies by which an action can be accomplished. Screening will eliminate those groups that are not technically feasible at the site.

- Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.

- Assemble the selected representative technologies into site closure and corrective action alternatives for the bedrock, surface water, surficial materials and groundwater of the IHSS areas of OU8 that represent a range of treatment and containment combinations, as appropriate.

- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the screening evaluation reduces the number of alternatives that will undergo thorough and extensive analyses, alternatives will be evaluated in less detail than subsequent evaluations.

Determining the effectiveness of alternatives involves an evaluation of the protection of human health and the environment achieved by a remedial action during construction and implementation and after the response objectives have been met. Evaluation of short-term effectiveness is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term effectiveness addresses the risk remaining to human health and the environment. It is based on the percentage of permanent destruction, decreased mobility, and/or reduction in volume of toxic compounds achieved after response objectives have been met.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate

the combinations of process options with respect to the site-specific conditions. Technical feasibility refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. Administrative feasibility refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for similar sites at RFP, with modifications made for current RFP conditions. Precise estimates are not necessary. However, the cost estimates for comparison and screening will have the same relative accuracy. The cost estimating procedures used during screening are similar to those that will be used during the later detailed alternatives analyses. However, the later detailed analysis will receive more in-depth and detailed estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment operations at the site. Present worth cost analysis will be used to make the costs for the various alternatives for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than ten alternatives will be retained for detailed analysis (including containment and no action). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. It will also be necessary to identify and verify the action-specific applicable or relevant and appropriate requirements (ARARs) for each alternative.

The Phase I RFI/RI Work Plan identifies the appropriate level of alternatives analyses and involves listing general response actions most applicable to the type of site under investigation. General response actions are broadly defined as those that may satisfy the objectives for remediation defined for OU8. Those objectives include the protection of human health and the

environment from ingestion, dermal contact or inhalation of contaminants that may be present in the bedrock, wastes, surficial materials, surface water, or groundwater in the OU8 area through remediation. Table 4.7-1 provides a list and description of general response actions and typical technologies associated with remediating soils, wastes, groundwater, surficial materials, and surface water. Table 4.7-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSS areas of OU8. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 4.7-1 must be applied to the potential exposure pathways that will be identified for OU8. The response actions may provide control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that control all pathways.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where contact with the released contaminant could be prevented.

While the identification of general response actions is discussed above, the selection of the most appropriate action or combination of actions is not warranted at this time. Site and contaminant data are not sufficient to initiate the screening process. Phase I will generate data necessary to characterize the source and soils and will evaluate the impact of OU8 on surface water, groundwater, air, the environment, and biota in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

- Describe the physical characteristics of the site;
- Define sources of contamination;

- Determine the nature and extent of contamination in soil, groundwater, surface water, sediments, and air;
- Describe contaminant fate and transport; and
- Describe receptors.

These data will provide information for the preliminary screening of alternatives and a thorough, comparative evaluation of the technologies with respect to implementability, effectiveness, and cost. This information will allow for informed decisions to be made with respect to the selection of preferred technologies. The Field Sampling and Analysis Plan (FSAP) in Section 6.0 describes the methodology that will be followed to obtain the required information for the Phase I RFI\RI characterization.

Detailed Analysis of Remedial Alternatives

The detailed analysis of each alternative will be performed when sufficient data are generated. The detailed analysis and selection of alternatives is not a final decision-making process; rather, it is the process of analyzing and comparing relevant information in order to select a preferred remedial action. In accordance with the NCP, containment technologies will generally be appropriate remedies for wastes that pose a relatively low-level threat or where treatment is impracticable (EPA, 1991). Each appropriate alternative will be assessed in terms of nine evaluation criteria, and the assessments will be compared to identify the key attributes among the alternatives. Assessment based on the nine evaluation criteria is necessary for the Corrective Measure Study (CMS) and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine evaluation criteria are as follows:

1. Overall protection of human health and the environment;
2. ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;

5. Short-term effectiveness;

6. Implementability;

7. Cost;

8. State acceptance; and

9. Community acceptance.

These criteria are described in recently revised guidelines provided in the National Contingency Plan (NCP). The first two criteria are considered standards because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the balancing items on which the analysis is based. The final two criteria are addressed during the final decision-making process after completion of the CMS/FS.

4.7.2 Air

Atmospheric transport is characterized by short migration times, relatively large areas of exposure, and an inability to mitigate the potential consequences of a contaminant release once it occurs. As such, effective air pathway contaminant control will emphasize source emissions reduction and containment prior to atmospheric release. Conventional technologies that may be employed during OU8 Work Plan implementation to suppress fugitive dust and volatile organic emissions include application of water sprays, surfactants, or dust suppressants and installation of wind-screens or membrane coverings. Such methods will be applied when personnel protection monitoring (as implemented according to the Site-Specific Health and Safety Plan) indicates the need for mitigative action during Work Plan implementation.

4.8 TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or

appropriate to support the OU8 RFI/RI. EG&G has prepared a site-wide Treatability Studies Plan which addresses this Task. The site-wide studies will be utilized as appropriate for OU8.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis, and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU8 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, ft may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

Air Stripping - Air stripping Is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can

usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater. More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site. In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent. A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as g/L. Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste.

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

In Situ Biological Treatment - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process Is relatively inexpensive.

Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment Is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until ft melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of Inorganic, metal, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

Physical Separation - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material

that requires further treatment. The processes used for soil size fractionation include screening, classification, flotation, and gravity concentration.

Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

4.9 REMEDIAL INVESTIGATION REPORT

An RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RI report. This will include any deviations from the Work Plan that occurred during implementation of the field investigation.

- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.

- Present a Preliminary Site Characterization based on all RFI/RI activities at OU8 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.

- Discuss contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors.

- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.

- Present a summary of the findings and conclusions.

- Identify data gaps and work to be performed for the Phase 11 investigation.

TABLE 4.7-1

General Response Actions
Typical Associated Remedial Technologies and Evaluation

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
No Action.	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and Use Restrictions.	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security, fencing, deed use restrictions, and warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restrictions would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping, groundwater containment barriers, soil stabilization, and enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Groundwater pumping, leachate collection, and liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, and contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

TABLE 4.7-1 (Continued)

General Response Actions

Typical Associated Technologies and Evaluation

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
In Situ Treatment	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification and bioremediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways.
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfills and repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, could be used to control corresponding pathway (except air).
Monitoring	Short-and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
125	Approximately 10 foot spacing on the northeast side of tanks only. Buildings and a loading dock restrict access on other sides of the tank.	2 boreholes will be located hydraulically downgradient of the tanks.	10 feet below the base of the tank.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples. Both boreholes will be converted to groundwater monitoring wells.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
126.1 & 126.2	Approximately 10 feet apart on the northeast side of the tanks.	2 boreholes will be located immediately downgradient of each of the tanks .	10 feet below the base of the tanks.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples. Both boreholes will be converted to groundwater monitoring wells.
127	20 foot spacing.	6 boreholes 4 additional boreholes will be located along the route of the pipeline between buildings 774 and 995.	10 feet below the pipe invert carrying waste between buildings 995 and 774 or 6 feet into weathered bedrock whichever is shallower.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Matric potential samples will be collected at 2 foot intervals.
132	Borehole spacing will be determined based upon the tank spacing and configuration.	The number of boreholes will be determined based upon the tank spacing and configuration.	10 feet below the bottom of the tank or 6 feet into weathered bedrock whichever results in a greater total depth.	6 foot composites	Geologic logs will be prepared over the entire depth of the boring.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
135	25 foot spacing	30 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
137	20 foot spacing	10 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
138	25 foot spacing	9 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
139.1 & 139.2	15 foot spacing	20 boreholes each	6 inches	Not applicable	Geologic logs will be prepared over the entire depth of the boring.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
144	Approximately 10 foot spacing along the route of the sewer line, and 30 foot spacing on the affected hillside.	2 boreholes adjacent to the sewer line. 4 boreholes located on the affected hillside.	5 feet below the pipe invert or 6 feet into weathered rock. 6 feet into weathered rock.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled.	Geologic logs will be prepared over the entire depth of the boring.
146.1 - 146.6	Approximately 30 foot spacing.	6 boreholes located immediately adjacent to the tanks.	10 feet below the tank inverts.	6 foot composites for all of the boreholes. For 3 of the 6 boreholes, after the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and sampled for TCL volatiles and semi-volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
149	50 foot spacing	11 boreholes	5 feet below the invert of the waste lines or 6 feet into weathered bedrock.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
150.1 - 150.8	150.1 - 50 foot spacing 150.2 - 50 foot spacing 150.3 - 2 rows of 3 boreholes 150.4 - 2 rows of 4 boreholes 150.5 - 75 foot spacing 150.6 - 2 rows of 4 boreholes 150.7 - 50 foot spacing 150.8 - 40 foot between boreholes on a linear transect	9 boreholes 20 boreholes 6 boreholes 8 boreholes 10 boreholes 8 boreholes 10 boreholes 3 boreholes	6 feet into weathered bedrock	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
151	Not applicable	4 boreholes spaced uniformly around the tank and immediately adjacent to it.	5 feet below the bottom of the tank or 6 feet into weathered bedrock whichever is greater.	After the first foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
159	20 foot spacing	7 boreholes	5 feet below the invert of the waste lines.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
163.1 & 163.2	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	10 feet	After the first foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled.	Geologic logs will be prepared over the entire depth of the boring.

TABLE 4.3
DATA QUALITY OBJECTIVES SUMMARY Attachment a

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
172	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	.5 feet	.5 foot composites	None
173	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	Surface grab sample.	Not Applicable	None

5.0 DATA NEEDS AND DATA QUALITY OBJECTIVES

5.1 SUMMARY OF IMPACTS, DATA GAPS, AND OTHER REQUIREMENTS

5.1.1 Surficial Material, Bedrock, and Groundwater

This subsection summarizes the information provided in previous subsections on possible impacts to surficial material (artificial fill, alluvium, and soil), bedrock and groundwater resulting from activities or releases occurring at each OU8 IHSS. In addition, this subsection summarizes the data required to determine the nature and extent of contamination of surficial materials, bedrock, and groundwater attributable to each IHSS.

The historical information and data provided in Sections 2.3, 2.4, and 2.5 indicate that the potential exists that releases from OU8 may have resulted in impacts to surficial materials, bedrock, and groundwater. Due to the available time and the extensive volume of existing analytical data available from RFEDS for these media in the vicinity of these IHSSs, these data have not been fully evaluated to determine whether such impacts have been detected. The evaluation of these data is necessary to characterize the nature and extent of contamination potentially associated with the IHSSs, refine the IHSS conceptual models, and identify data to be collected during field investigations of each IHSS.

Appendix E describes the approach that will be followed to evaluate existing data pertinent to OU8. This evaluation will be completed for all OU8 IHSSs prior to preparation and submission of the Final Work Plan for OU8. Appendix E also provides a preliminary evaluation of the available analytical data for IHSSs 118.1, 118.2, 139.1(N), 139.1(S), 139.2, and 188. This evaluation is an example of the type of evaluation that will be completed for each IHSS to develop data acquisition requirements for each IHSS.

The data presented in Appendix E indicate that some of these IHSSs may have impacted surficial materials, bedrock, and groundwater. However, the data that are currently available are not of sufficient quantity or quality to allow a determination of the nature and extent of contamination attributable to these IHSSs. The existing sampling points were not installed to monitor releases from these IHSSs and, therefore, are not ideally located for such a purpose. The distance between these sampling points and these IHSSs is generally too great for meaningful conclusions regarding releases from these IHSSs to be made. The determination of impacts that may attributable to these IHSSs is further complicated by the presence of IHSSs to be investigated under other operable unit investigations and other potential sources of contamination in close proximity to or upgradient from many of the OU8 IHSSs. Based on this preliminary evaluation, additional data is needed on surficial material, bedrock, and groundwater conditions in proximity to these IHSSs. In addition, information is needed regarding other potential sources of contamination that may have impacted these media in the vicinity of these IHSSs.

5.1.2 Surface-Water and Sediments

The purpose of this section is to summarize probable surface-water impacts and data requirements associated with the planned Phase I RFI/RI efforts. To the extent possible, reference is made to available relevant data and information sources.

5.1.2.1 Approaches

Available sediment-chemistry and water-quality data from RFEDS database were retrieved for inclusion in this Work Plan for the following general categories of constituents:

- Radionuclides;
- Trace metals (including major cations and silicon);
- Priority pollutants; and
- Pesticides, major anions, and miscellaneous chemical constituents.

All surface-water and sediment monitoring sites used in this evaluation are indicated on Figure 1-12 and in Table 5.1.1. The resultant data were evaluated, and when applicable, selective comparisons were made with geochemical-characterization results reported in EG&G documents (EG&G,1990b; EG&G 1991c).

For development of this RFI/RI work plan, available data were compared, as appropriate, with EPA's drinking-water standards (ASI, 1991b; Appendix F), the Colorado Department of Health's (CDH's) Water Quality Control Commission (WQCC) stream standards (ASI, 1991a; Appendix F), or the proposed groundwater concentration limits (EG&G, 1991g; Table 3.2). In addition, the applicable Federal and State of Colorado ARARs (EG&G, 1990b) and RFP surface-water background concentrations (Table 5.1.2 and 5.1.3) were used for comparison.

Data from the following surface-water and sediment sampling sites included in the RFEDS data retrieval (EG&G, 1992) were used in this analysis:

- SW018
- SW023
- SW102
- SW120
- SW122
- SW132
- SED011
- SED120
- SED124

In addition, data for sites SW061, SW124, SW133, and SED010 were requested, but not received with the RFEDS retrieval.

5.1.2.2 Results

Available surface-water, water-quality, and sediment-chemistry data judged applicable to characterizing OU8 conditions cannot be segregated completely from other OUs. Locations of surface-water monitoring sites are such that impacts of IHSSs associated with other OUs may

affect noted characteristics as documented by water-quality and sediment-chemistry data at these sites.

Surface Water

Regarding radionuclides, gross-alpha and gross-beta data were used in this assessment as indicators. Based upon EG&G (EG&G 1990b; Table 3.7), the reported ARARs and CDH-WQCC stream standards for total gross-alpha and total gross-beta concentrations are 11 pCi/l and 9 pCi/l, respectively (ASI, 1991a). In comparison, the reported background limits for these two indicator radionuclides in surface water are 177 and 163 (rounded) pCi/L for total gross-alpha and total gross-beta concentrations, respectively (Table 5.1.2). Surface water data for RFP are available for the following radioisotopes: americium-241; cesium-137; plutonium-239/240; radium-226; radium-228; strontium-89/90; tritium; uranium-233/234; uranium-235; and uranium-238 (EG&G, 1992). A statistical analyses of the available specific radioisotopic data was not included in this assessment.

The stream standard for gross alpha was exceeded by up to 850 percent at surface water sampling site SW102, which is in the North Walnut Creek drainage basin. The background value for gross alpha was not exceeded at any of the surface water sampling sites included in this assessment. The stream standard for gross beta was exceeded at SW102 (by up to 600 percent) and at SW023 (by up to 200 percent), while the background level was not. SW023 is located within the South Walnut Creek drainage basin.

Regarding trace metals (including major cations and silicon), analyses were made relatively frequently for up to 24 trace metals, the four major cations (calcium, magnesium, potassium, and sodium), and relatively infrequently for silicon. For most of the samples collected, analyses were performed for both dissolved and total concentrations.

The ARARs or associated CDH-WQCC stream standards exist for the trace metals (EG&G, 1990b; Table 3.7). Whenever appropriate, comparable EPA drinking-water standards should be used for comparison (ASI, 1991a). Background concentrations for several metals were exceeded at SW018, SW023, SW102, SW122, and SW132.

Regarding priority pollutants (semivolatile/volatile compounds), applicable ARARs and CDH-SWCC standards for selected chemicals in this category of constituents are reported (EG&G, 1990b; Table 3.7). Data on priority pollutants were not found for samples SW102, SW122, and SW132. For sites SW018 and SW023, chemical constituents found in detectible concentrations are carbon tetrachloride and chloromethane at SW018, and methylene chloride and acetone at SW023.

Regarding the category of pesticides, major anions, and other miscellaneous chemical constituents, no data for SW102, SW122, and SW132 were found. The associated ARARs and CDH-WQCC standards for some of these constituents are reported in EG&G (EG&G, 1990b; Table 3.7); however, no background limits were specified. In the case of data on major anions or other miscellaneous constituents (such as percent moisture, pH, selected nutrient species, dissolved solids, and suspended solids associated with surface waters), no evaluation was made of values in the RFEDS retrievals during the preparation of this work plan, because these constituents were not particularly useful in discerning sources or extent of contaminants relative to the other variables discussed above.

Sediments

Regarding radionuclides in sediments, gross-alpha and gross-beta data were used as indicators, as discussed above for characterization of surface-water. Based upon EG&G (EG&G, 1990b; Table 3.7), no ARARs or CDH-WQCC stream standards are applicable for gross-alpha or gross-beta concentrations analyzed on stream sediments. The reported background limits for these two indicator radionuclides in surface water are 57.75 and 51.76 (rounded) pCi/L for gross-alpha

concentrations and gross-beta concentrations, respectively (Table 5.1.3). Background gross-alpha and gross-beta concentrations were not exceeded in any of the three sediment sites (SED011, SED120, and SED124). Concentrations of several metals were below background levels at all sediments sites.

5.1.2.3 Conclusions

Selective aspects of continuing surface-water monitoring programs at RFP will aid further in the characterization as well as assessment of identified areas of concern regarding existing or potential contamination in the OU8 area. Subsequent data analyses should be more detailed and focus on selected chemical-constituent and ancillary hydrologic data identified with past activities in OU8. Causes and possible sources of contamination are documented and descriptions of the IHSSs included in OU8 (Doty and Associates, 1992). Qualification of possible impacts of IHSSs and conditions in other OUs that are unrelated to OU8 impacts, as noted previously are also documented (see Sections 2.4 and 2.5).

5.1.3 Summary of Air Monitoring Impacts and Other Requirements

5.1.3.1 Data Collection Systems

The air quality and meteorological monitoring programs currently in effect at RFP were designed to collect data on the entire facility; Air sampling stations have not been located or operated specifically in support of Operable Unit 8. Continuous ambient air monitoring programs have emphasized characterization of airborne particulate material concentrations and accompanying radionuclides, particularly plutonium. A systematic program for measurement of volatile organic compound (VOC) concentrations in RFP ambient air has not been initiated; however, a dispersion model-derived ambient air concentration study was scheduled to be completed in late 1991 (EG&G, 1991j). Meteorological data is being collected at one location at RFP. Telemetered wind measurements are collected at the RFP 61-Meter Meteorological Tower (Figure

1-2) (EG&G, 1990c). These data are apparently not available in an annotated form directly suitable for atmospheric dispersion modeling.

Ambient air samplers are located in RFP site operations areas, at the plant perimeter (at distances of approximately 2 to 4 miles from the plant's center), and in surrounding communities. These RFP-designed air samplers operate at a volumetric flow rate of 25 ft^3/min. The units collect air particulates on 8- by 10-inch fiberglass filter media with a manufacturer's test specifications rating of 99.97% efficiency for particle sizes typically encountered during routine ambient air sampling (EG&G, 1990c).

Table 4.7.1 identifies the sampling equipment used for continuous measurement of airborne particulates. RFP samplers monitor ambient air for both Total Suspended Particulates (TSP) and Particulate Matter with aerodynamic diameters of 10 microns or less (PM-10). TSP and PM-10 samplers located near the east entrance to RFP are of particular importance because this location is unobscured by structures, is situated near a traffic zone, and is generally downwind from plant buildings and contaminated surfaces. Samplers are operated on a schedule of one day every sixth day. TSP is measured by the EPA-referenced, high-volume air sampling method (EPA, 1981).

5.1.3.2 Radionuclide Monitoring

The Radioactive Ambient Air Monitoring Program (RAAMP) collects particulate ambient air sampler information in order to track the dispersion of airborne radioactive materials from RFP into the surrounding environment as well as establish baseline concentrations. Samplers are assigned into one of three categories, depending upon their proximity to the main facilities area. Twenty-five onsite samplers are located within RFP and are concentrated near the main facilities area. Fourteen perimeter samplers border RFP along major highways to the north, east, south, and west. Fourteen community samplers are located in the metropolitan areas adjacent to RFP (EG&G, 1990c).

RAAMP monitor locations within and adjacent to the RFP operations area are shown in Figure 5-1. During 1988, sample filters were collected biweekly from twenty-three locations and analyzed for total long-lived alpha (TLL-α) radiation. If the TLL-α activity for an ambient air sample exceeded the plant guide value of 10×10^{-15} μCi/ml (3.7×10^{-4} Bq/m^3), a specific plutonium analysis was performed on the collected sample. Filters from five of the twenty-three onsite samplers were routinely analyzed biweekly for plutonium (S-5 through S-9, Table 5.1-5__). The mean concentrations of plutonium in ambient air at the five onsite stations during 1988 ranged from 0.149×10^{-15} to 0.710×10^{-15} μCi/m^3 (5.51×10^{6} to 2.63×10^{-5}Bq/m^3). These concentrations represented less than four percent of the offsite Derived Concentration Guide (DCG) for plutonium in air. These five onsite samplers have historically exhibited the highest TLL-α activities for the RAAMP network (Rockwell, 1988).

During 1990, filters were also collected biweekly from all RFP samplers. Each biweekly onsite sampler filter was analyzed separately every month except in December. Filters collected in December were composited by location into one onsite sample. Filters from perimeter and community samplers were collected biweekly, composited by location, and analyzed monthly for plutonium. Plutonium concentrations for onsite samplers during 1990 are provided in Table 5.1-6. Overall mean plutonium concentration for onsite samplers was 0.072×10^{-15} μCi/ml (2.7×10^{-6} Bq/m^3), or 0.36 percent of the offsite DCG for plutonium in air. By comparison, the overall mean plutonium concentration for perimeter samplers was 0.003×10^{-15} μCi/ml (1.1×10^{-7} Bq/m^3); The mean plutonium concentration for community samplers was 0.001×10^{-15} μCi/ml (3.7×10^{-8} Bq/m^3). These values are 0.013 percent and 0.005 percent, respectively, of the offsite DCG (EG&G, 1991).

Mean annual plutonium concentrations for 1986-1990 are shown in Figure 5-2 (onsite samplers) and Figure 5-3 (perimeter and community samplers). Onsite data were based on samplers S-5 through S-9; Isotope-specific analyses were not reported for other onsite locations until 1990 (EG&G, 1990).

5.1.3.3 Nonradiological Particulate Monitoring

Nonradiological particulate data collected by the RFP ambient air monitoring system are shown in Table 5.1-7 (EG&G, 1990). The highest TSP value recorded in 1990 (24-hour sample) was 134 micrograms per cubic meter ($\mu g/m^3$) or 51 percent of the former TSP 24-hour primary standard. The annual geometric mean value was 31.4 $\mu g/m^3$ or 12 percent of former TSP primary annual geometric mean standard. The observed 24-hour maximum for the PM-10 sampler was 26 $\mu g/m^3$ or 17 percent of the primary 24-hour standard, and the annual arithmetic mean was 9.8 $\mu g/m^3$ or 20 percent of the primary annual arithmetic mean standard. Mean annual concentrations of particulates for onsite ambient TSP samplers (1986-1990) and PM-10 samplers (1988-1990) are shown in Figure 5-4, (EG&G, 1990).

5.1.3.4 Air Data Usability

Air quality and meteorological monitoring programs at the RFP routinely emphasize meteorological parameters, total suspended particulates, and ambient air concentrations of particulate radionuclides. While a record of area radionuclide concentrations and trends is important, the specific identity of contaminant sources and the conditions of typical and maximum atmospheric input from OU8 IHSS sites cannot be ascertained. Existing ambient air data are not sufficient for application in an IHSS site-specific human health risk assessment. Although there are air monitoring stations operating at or near OU8, they measure aggregate airborne particulate concentrations regardless of source. Furthermore, their operational schedule of the monitoring stations are currently independent of OU8 activities.

However, existing ambient monitoring of existing sites can provide important records of historical trends, establish current baseline conditions, and characterize major deviations in concentrations that might result in IHSS site-specific actions. It must be remembered that this data is not provided on a real-time basis, and uncertainty will always exist with these monitors concerning to multiple contaminant sources. As such, additional IHSS site-specific ambient monitoring will

be required during OU8 Work Plan implementation. This monitoring will be performed in conjunction with site worker safety monitoring.

The routine RFP ambient air quality monitoring network does not gather data relevent to outdoor-contaminated surface-area source releases of volatile organic compounds (VOCs). A complete human health risk assessment for IHSS site VOCs will require additional information on the identity, emissions rate, dispersion, and ambient concentrations of VOCs originating from OU8. However, source concentrations of airborne VOCs to the air pathway (particularly with regards to individual OU8 IHSS sites) appear limited and would probably exist below the minimum detection levels of ambient detectors at all locations except the immediate vacinity of the source. As such, theoretical flux rates to the atmosphere can be derived from OU8 soil gas surveys. Coupled with dispersion models to support order-of-magnitude risk assessments, they can be used to determine VOCs should it be deemed necessary.

5.2 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are established to define data needs for each of the RFI/RI tasks, coordinate data collection activities in support of those needs, and to ensure that the resultant data are of adequate quantity and quality to achieve the technical and regulatory objectives of the RFI/RI process. Collectively, the data are used to make decisions regarding the risks the site poses to human health and the environment and to make decisions regarding which remedial measures are appropriate to mitigate the risks. DQOs are developed interactively with ongoing RFI/RI activities. The DQO development process is flexible, iterative and dependant upon evaluation of existing data, and data that become available as a result of RFI/RI activities. Three stages are used in the development of DQOs, and each of the stages is outlined below (EPA, 1987).

Stage 1 - Identify Decision Types

- Identify and involve data users;
- Evaluate available data;

- Develop a conceptual model of the study site; and
- Specify RFI/RI objectives and anticipate the decisions that may have to be made in order to achieve the objectives.

Stage 2 - Identify Data Uses and Needs

- Identify data uses
- Identify data types
- Identify data quality needs
- Identify data quantity needs
- Evaluate sampling and analysis options
- Review data precision, accuracy, representativeness, completeness and comparability (PARCC)

Stage 3 - Design Data Collection Program

- Assemble data collection components
- Develop data collection documentation

The DQO elements are continually revised and reevaluated on the basis of new data developed during each phase of the RFI/RI. As the environmental characteristics and the nature of contamination of the study area become clearer, additional data requirements will become apparent and both the DQOs and the Field Sampling and Analysis Plan (FSAP) may evolve in response to these requirements. The succeeding discussion addresses each of the DQO elements.

5.2.1 STAGE 1 Identification of Decision Types

5.2.1.1 Identification of Data Users

The following is a list of agencies and organizations that are the principal decision makers and end users of data that will be generated during the OU8 Phase I RFI/RI (EG&G, 1991i).

United States Environmental Protection Agency, Region VIII, Waste Management Division Director, Federal Facilities Branch Chief and the Rocky Flats Remedial Project Manager.

State of Colorado Department of Health, Hazardous Materials and Waste Management Division Director, Hazardous Waste Section Leader, Hazardous Waste Facilities Unit Leader, and the Monitoring and Enforcement Unit Leader.

United States Department of Energy, Office of Environmental Restoration and Waste Management, Secretary of Energy, and the Acting Assistant Secretary for Environmental Restoration and Waste Management.

United States Department of Energy, Rocky Flats Office Manager, Assistant Manager for Environmental Management, and the Acting Environmental Restoration Division Director.

EG&G Rocky Flats Plant, Environmental Management Department, Associate General Manager for Environmental Restoration and Waste Management, Environmental Management Department Director, Environmental Management Department Division Managers, and matrix project personnel from other Rocky Flats Plant or external EG&G organizations.

EG&G Rocky Flats Plant technical specialists and subcontractors responsible for supervising, coordinating and performing Environmental Restoration activities (EG&G, 1991i).

5.2.1.2 Evaluation of Available Data

Soils and geologic data collection activities in the vicinity of OU8 have been primarily directed towards defining the Rocky Flats Plant environmental setting; the data were developed as a result of the Rocky Flats Plant Geological Characterization. Chemical data used to characterize the types and sources of contamination present in the soils and groundwater were collected as a result of the Rocky Flats Plant Geological Characterization. The soils and geologic data that are available were not developed for the specific purpose of characterizing OU8.

Existing ambient air monitoring programs characterize the Rocky Flats Plant site on an area-wide basis for total suspended particulates, PM_{10}, plutonium and americium. Rocky Flats Plant site air monitoring stations are shown in Figure 5-2.1. This data is not specific to any of the OU8 IHSS sources, but provides a baseline for the Rocky Flats Plant and is collected according to air sampling procedures specified in EMD Operating Procedures Manual No. 5-21000-OPS-AP, Volume VI, Air.

Surface water data (metals, water quality, and radiochemistry) for OU8 is available from 31 sampling stations located in 2 drainage basins reference Figure 1-2 in Section 1.6.6 of this document.

Data for surface water, groundwater, soils and geology are in the process of being validated in accordance with sections 3.4 and 3.7 of the Rocky Flats Plant Site-Wide Quality Assurance Project Plan. Some of the data are validated and accepted, some are validated with qualifications, some have been rejected and some have yet to go through the validation process. The Rocky Flats Environmental Database lists the available analytical data and identifies which samples have been validated.

5.2.1.3 Site Conceptual Model

Conceptual models of IHSSs in OU8 have been developed and are presented in Section 2.5 of this document. The models include a description of potential sources of contamination, release mechanisms, media, transport, exposure routes, and potential receptors. The conceptual models were developed by organizing the IHSSs into four logical groups based primarily upon the type of contaminant, release mechanism, and geographic location. The five groups, and the IHSSs that compose each group, are listed below.

- Leaks spills and overflows of tanks and pipelines - IHSSs 123.1, 123.2, 125.0, 126.1, 126.2, 127.0 132.0, 135.0, 137.0, 138.0, 144.0, 146.1, 146.2, 146.3, 146.4, 146.5, 146.6, 149.0, 150.3, 150.4, 150.5 and 159.0.
- Releases associated with fires and explosions - IHSSs 150.1, 150.2, and 150.7.
- Ground surface leaks and spills, primarily of low volume, low level concentrations, and/or low potential for environmental damage - IHSSs 150.6, 150.8, 151.0, 163.1, 163.2, 172.0, 173.0, and 184.0.
- Caustic/acid/solvent spills - IHSSs 118.1, 118.2, 139.1, 139.2, and 188.0.

The conceptual model will be used as an aid in identifying exposure pathways, and to evaluate the potential risks to human health and the environment posed by the contamination present in OU8.

5.2.1.4 Data Objectives and Decisions

The DQO process requires that specific data objectives be defined; formulation of the objectives leads to the identification of data uses, needs and types. The data objectives for the OU8 RFI/RI Work Plan are summarized in Table 5.2-1. Data needs are expected to evolve based upon new information generated as the Work Plan is implemented.

5.2.2 Stage 2 - Identify Data Uses and Needs

5.2.2.1 Identify Data Uses

The principal uses of RFI/RI data have been defined in Data Quality Objectives for Remedial Response Activities and are listed below (EPA, 1987).

- **Site Characterization** - data are used to determine the nature and extent of contamination at a site;
- **Health and Safety** - data are used to establish the level of protection needed for on-site workers and to determine if there is imminent danger to the surrounding population;
- **Risk Assessment** - data are used to evaluate the threat posed by the site to public health and the environment;
- **Evaluation of Alternatives** - data are used to evaluate which remedial technologies may be appropriate;
- **Engineering Design of Alternatives** - data are used in the remedial design process to evaluate the performance of various remedial technologies;
- **Monitoring During Remedial Action** - after remedial actions are implemented, data are used to assess their effectiveness; and

Data uses specific to RFI/RI Phase I sampling and analysis activities for OU8 are listed in Table 5.2-2.

5.2.2.2 Identify Data Types

Data types required for the OU8 RFI/RI are: air quality, soil engineering/geotechnical, soil-gas, soil chemistry, surface water flow measurements, surface water chemistry, aquifer parameters, and groundwater chemistry. Table 5.2-2 provides additional information on the types of data that will be collected.

5.2.2.3 Identify Data Quality Needs

The level of data quality required for OU8 RFI/RI activities is based upon the following factors: appropriate analytical levels, contaminants of concern, level of concern, required detection limit, and critical samples. Each of these factors is discussed below.

Appropriate analytical levels for RFI/RI work are listed below (EPA, 1987).

- **Level I** Field portable instruments. Results are typically not compound specific and not quantitative. This analytical level is appropriate for providing real time health and safety data, and as a screening tool to indicate potentially contaminated areas.

- **Level II** Mobile laboratories and field gas chromatograph/mass spectrometer (GC/MS) units. Results may be compound specific and quantitative depending on instrument calibration, reference standards, equipment condition and operator capability. Real time data may be available, or results may be produced in several hours. This analytical level is appropriate during the site characterization, evaluation of remedial alternatives, engineering design, and during site monitoring.

- **Level III** Off-site analytical laboratory. Results generally have a greater degree of analytical precision than Level II. Data may be available in 24 hours or in a period of several days to weeks. Level III is an appropriate level for

some phases of site characterization, risk assessment, evaluation of remedial alternatives, engineering design, responsible party determination, and during site monitoring.

- **Level IV** EPA Contract Laboratory Program. The analytical precision is similar to that of Level III, but stringent quality assurance and quality control protocol are formally documented. Laboratory turn-around-times for reporting analytical results are similar to those described for Level III.

- **Level V** Off-site analytical laboratory using non-standard methods. Analytical method development or modification is required and analytical precision and reporting schedules may vary according to the method.

Analytical Level I through Level IV will be used during implementation of the OU8 RFI/RI. The analytical methods that will be used are those specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B (EG&G, 1991b).

Contaminants of concern have been selected to assist in determining the extent of contamination and as an aid in developing a risk assessment. The criteria for selecting the contaminants of concern are high toxicity, high mobility, persistence in the environment and frequency of occurrence. The contaminants of concern are listed in Table 5.2-3; as additional data become available, the list is expected to evolve.

Levels of concern are based upon available standards and are expressed as contaminant specific concentration ranges that serve as guidelines for selecting analytical methods and detection limits and in determining the limits of field investigations.

Detection limit requirements take into account the levels of concern, RFP chemical specific Benchmarks in lieu of Applicable or Relevant and Appropriate Requirements (ARARs), and Data Quality Objectives specified in the Rocky Flats Plant Site-Wide Quality Assistance Project Plan (EG&G, 1991a). Site-specific ARARs will be developed as the initial step in the corrective

measures study. Detection limits are listed in Table 5.2-3 and in the Field Sampling and Analysis Plan (FSAP).

Critical samples may be collected in duplicate from areas that are considered vital to the RFI/RI decision making process. Selection of critical samples will occur after initial site scoping surveys have been completed.

5.2.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on a review of the available environmental data, and on an assessment of additional data required to adequately characterize the site and the nature of contamination at OU8. The rationale for sampling quantities is described in the FSAP presented in Section 11 of this Work Plan. The FSAP recommends a staged approach to data collection to locate critical sampling sites. Field sampling density will be based upon methodologies and statistical guidance contained in Data Quality Objectives For Remedial Response Activities (EPA, 1987), sample density criteria specified in Table 5 of the IAG (DOE, 1991), and site specific information available from the Historical Release Report and developed as a result of preparing this Work Plan.

Based upon the available data, and the site conceptual model, additional data will be collected for the OU8 Phase I RFI/RI (Table 5.2-3). Additional data are needed to adequately characterize the sources of the contamination, the nature and extent of contamination, and to support a baseline risk assessment, and assessment of remediation alternatives.

5.2.2.5 Evaluate Sampling/Analysis Options

RFI/RI data collection and analysis for OU8 will utilize a graduated approach in which Analytical Level I and Level II field screening techniques will be used to focus subsequent data collection and analysis for Analytical Levels III through V. The sampling/analysis options selected are

based upon their ability to obtain data that is consistent with known site conditions and that satisfy the IAG Preliminary Work Plan and amendments thereto.

Field screening techniques will be used whenever possible to reduce waste generated during sample collection, minimize delays that can result when more exacting analytical methods are used, and to minimize worker exposure. Analytical Level I and Level II field screening will be used to assess both radiochemical and organic chemical contamination. Radiological surveys using a G-M shielded pancake detector and side shielded FIDDLER will be conducted to identify areas of radiochemical contamination that may require further investigation. A High Purity Germanium (HPGe) detector will be used to for radiation surveys conducted on IHSSs that are believed to have shallow soil contamination, are not covered by asphalt, and are large enough to accommodate the HPGe's radius of investigation. Data collection procedures will be in accordance with the Environmental Management Radiological Guidelines Manual (EG&G, 1991e). Soil-gas surveys utilizing a portable GC will be used to identify areas of organic chemical contamination and to direct further sampling efforts. Data collection procedures will be those specified in Environmental Management Division Manual 5-21000, Volume III, Geotechnical (EG&G, 1992c). Photoionization detectors will be employed for health and safety purposes.

Surface scrape samples will be collected at IHSSs suspected or known to have radiological contaminants. These samples will serve as an additional screening tool prior to more invasive sampling techniques such as drilling. Depending upon historical records for each IHSS, surface scrape samples may be analyzed for total plutonium, total americium, total uranium, tritium, uranium-238, uranium-235, uranium-233/234, gross alpha and gross beta, beryllium, total chromium, nitrate, sodium, sulfate and Hazardous Substance List (TCL) volatiles and metals as specified in the IAG (DOE, 1991a). Surface scrape samples may be analyzed for PCBs based upon an the information contained in the Assessment of Known, Suspect and Potential Environmental Releases of PCBs Preliminary Assessment, Site Description. Analytical methods for each type of analysis will conform to a specific laboratory procedure referenced in the

GRRASP (EG&G, 1991a), these methods meet the criteria for analytical Level III through V. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical, (EG&G, 1992c).

Soil samples will be collected from boreholes as the initial step in assessing contaminant types and distribution. Depending on historical records for each IHSS, samples will be analyzed for total plutonium, total americium, tritium, gross alpha, gross beta, uranium-233/234, uranium-235, uranium-238, fluorides, nitrate, sodium, sulfate, TCL volatile compounds, TCL semi-volatile compounds, TAL metals and PCBs. Composite samples of six-foot intervals will be collected over the entire depth of the borehole after the first two foot interval has been drilled. Beginning two feet below the ground surface, one discrete sample will be collected from every other two foot interval drilled; these samples will be analyzed for TCL volatiles and TCL semi-volatiles. Analytical Level III will be used for soil samples. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical, (EG&G, 1992d).

Alluvial groundwater samples will be collected at IHSSs 125, 126.1 and 126.2 and from all existing piezometers and monitor wells in and immediately surrounding OU8. Additional wells may be installed based upon the results of the soil borings. Samples will be analyzed for nitrate, TCL volatile compounds, TCL semi-volatile compounds gross alpha, gross beta, total plutonium, total uranium, tritium and TAL metals. Quarterly groundwater data collection activities will support characterization of contaminant distribution as well as ongoing monitoring activities. Analytical Level IV (CLP protocol) will be used to analyze groundwater samples for analytes other than radiochemicals. Analytical Level V will be used for radiochemical analysis. Groundwater sampling and measurement of field parameters will be conducted in accordance with Environmental Management Division Manual 521000, Volume II, Groundwater (EG&G, 1991).

All data collection field records will be handled in accordance with the quality control procedures specified in Environmental Management Division Manual 521000, Volume I, Field Operations (EG&G, 1992c).

5.2.3 STAGE 3 - Design Data Collection Program

Stage three of the DQO process compiles the various elements of Stages one and two into a cohesive data collection program for the OU8 RFI/RI. To this end, a Quality Assurance/Quality Control Addendum (developed by EG&G) and a Field Sampling and Analysis Plan have been developed and are included as Sections 10.0 and 6.0, respectively, of this Work Plan. The results of the DQO process have been distilled into a detailed list (Table 5.2-3) of the number and type of samples to be collected, their location and analytical methods.

5.3 REVIEW OF PARCC PARAMETER INFORMATION

PARCC parameters (precision, accuracy, representativeness completeness, and comparability) for analytical Levels I through V are discussed below. Precision, accuracy and completeness goals are specified in the Quality Assurance addendum.

Precision is a quantitative measure of data quality that defines the reproducability or degree of agreement among replicate measurements of a single analyte. The closer the numerical values of the measurements are to each other, the more precise the measurements. One of methods used to estimate the precision of a method is the standard error of the estimates for the least square regression line of "measured" versus "target" concentrations (EG&G, 1991a). The primary role of this application is to characterize the precision of any analysis method under specified conditions, This allows comparison of different results produced by the same method. Analytical precision for a single analyte may be expressed as percentage of the difference between results of duplicate samples and matrix spike duplicates for a given analyte. Precision

will be determined from the results of duplicate and matrix spike duplicate analyses (EG&G, 1991a).

During the collection of data using field methods or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be reported as the relative percent difference for two results and as the standard deviation for three or more results. Sample collection precision shall be measured in the laboratory with the analysis of field replicates and laboratory duplicates (EG&G, 1991a). Analytical precision will be achieved by adhering to the analytical methods contained in the GRRASP (EG&G, 1991b). Sampling precision will be achieved by conforming to the procedures specified in the Environmental Management Division's Operating Procedure manuals referenced above.

Accuracy is a quantitative measure of data quality which refers to the degree of difference between measured or calculated values and the true value. The closer to the true value, the more accurate the measurement. One of the measures of analytical accuracy is expressed as a percent recovery of a spike or tracer which has been added to the environmental sample at a known concentration before analysis (EG&G, 1991a). While it is not feasible to totally eliminate sources of error that may reduce accuracy, the OU8 Work Plan attempts to minimize error by using standardized analytical methods and field procedures.

Representativeness is a qualitative parameter which expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EG&G, 1991a). Representative data will be obtained by using both biased and unbiased methods of selecting sample locations. Biased methods will employ existing data in areas known to be contaminated to determine the degree of contamination. Unbiased methods such as grid sampling will be used to determine both the nature and extent of contamination. Field work will be conducted according to standard operating procedures, further aiding the collection of representative data.

Completeness is a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. The objectives of the field sampling program are to obtain samples for all analyses required at each individual site, to provide sufficient sample material to complete those analyses, and to produce QC samples that represent all possible contamination situations; such as , potential contamination during sample collection, transportation or storage (EG&G, 1991a).

Comparability is a qualitative parameter describing the confidence with which one data set may be compared to another (EPA, 1987). The standard laboratory methods of the GRRASP (EG&G, 1991b) and standard operating procedures for conducting field work will allow for one to one comparability of OU8 RFI/RI data to other work conducted in conformance with those same standards.

TABLE 5.1.1

SURFACE-WATER AND SEDIMENT MONITORING SITES, OU8 IHSS ANALYSIS[1)]

I. North Walnut Creek Basin		II. South Walnut Creek Basin	
SW043	SED010[2)]	SW022	SED011
SW084	SED120	SW023	
SW085	SED124	SW056	
SW086		SW059	
SW087		SW060	
SW088		SW061[2)]	
SW089		SW101	
SW090		SW121[2)]	
SW102		SW122	
SW105		SW123	
SW106		SW132	
SW119[2)]		SW133[2)]	
SW120[2)]			
SW124			
SW371[2)]			

1) Monitoring site data retrieved from RFEDS (EG&G, 1992).

2) Data requested from RFEDS but no data recieved.

TABLE 5.1.2
BACKGROUND CONCENTRATIONS FOR SURFACE WATER SAMPLES

Total Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[1]	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium[1]
Upper Tolerance Limit (mg/l)	60.4235	..	..	..	..	..	43.3634	..	..	..	..	87.1476	..	..
Maximum Concentration (mg/l)	293.0	0.5U	1.03	4.49	0.0107	0.0644	226.0	2.53	0.275	0.489	0.607	3220.0	0.516	0.1U

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium[1]	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)	8.9377	1.9654	..	..	..	..	..	..	23.0992	..	..	..	..	0.3765
Maximum Concentration (mg/l)	28.5	27.7	0.0014	0.5U	0.646	10.2	0.025U	0.148	33.7	1.46	0.05U	0.969	1.65	2.68

Dissolved Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium[1]	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium[1]
Upper Tolerance Limit (mg/l)	..	..	..	..	..	..	37.8275	..	..	..	..	..	..	..
Maximum Concentration (mg/l)	0.485	0.5U	0.018	0.211	0.005U	0.005U	216.0	2.5U	0.02U	0.05U	0.0278	16.7	0.0131	0.102

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium[1]	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)	6.4118	0.5096	..	..	..	..	..	..	22.4768	..	..	..	..	..
Maximum Concentration (mg/l)	27.4	1.1	0.0013	0.5U	0.04U	2.6	0.0124	0.03U	35.2	0.967	0.05U	1.0U	0.05U	0.102

NA = Not applicable .. = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Surface Water

TABLE 5.1.2 (Cont.)
BACKGROUND CONCENTRATIONS FOR SURFACE WATER SAMPLES

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/l except pH)	202.1725	..	15.7253	..	9.0230	3.9883	36.9676
Lower Tolerance Limit (mg/l except pH)	NA	NA	NA	NA	5.5825	NA	NA
Maximum Concentration (mg/l except pH)	1900.0	5.0U	62.0	0.0452	9.8	11.0	560.0
Minimum Concentration (mg/l except pH)	NA	NA	NA	NA	5.0	NA	NA

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/l)	0.1769	3.9312	177.4289	163.2045	1.4577	29.2468	64.2265	1.6121	2022.4548	1.1054	0.1863	0.9186
Maximum Concentration (pCi/l)	0.372	12.0	440.0	420.0	4.4	30.0	24.0	1.95	980.0	1.51	0.22	1.4

NA = Not applicable .. = Value not calculated U = Concentration below detection limit [1] Value for North Rocky Flats Surface Water

TABLE 5.1.3
BACKGROUND CONCENTRATIONS FOR SEDIMENT SAMPLES

Metals

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
Upper Tolerance Limit (mg/kg)	8994.7474	..	..	..	..	..	..	..	20.8456	..	..	15664.9050	18.8158	..
Maximum Concentration (mg/kg)	21600.0	42.1U	13.0	182.0	3.5U	3.3U	52500.0	702.0U	30.4	35.1U	22.0	15000.0	49.1	70.2U

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/kg)	..	357.6192	..	..	..	..	..	..	..	..	..	..	24.1350	91.7952
Maximum Concentration (mg/kg)	4110.0	352.0	0.35U	70.2U	29.9	3510.0U	2.5U	6.8	3510.0U	397.0U	4.2U	70.2U	50.2	79.8

Inorganic Constituents

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	8.9280	..	..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	5.9878	NA	NA
Maximum Concentration (mg/kg except pH)					8.7	13.0	
Minimum Concentration (mg/kg except pH)					6.1	NA	

Radionuclides

	Americium-241	Cesium-137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium-235	Uranium -238
Upper Tolerance Limit (pCi/g)	0.0281	2.5959	57.7542	51.7571	0.0744	1.1701	1.5765	1.1015	1.1157	1.6135	0.9710	0.8462
Maximum Concentration (pCi/g)	0.02	3.2	48.0	41.9	0.08	1.1	2.3	0.99	0.97	1.48	1.34	1.3

NA = Not applicable .. = Value not calculated U = Concentration below detection limit

Table 5.1-4

Ambient Air Monitoring Detection Methods

Parameter	Detection Methods
Particulate Matter less than 10 micrometers in diameter (PM-10)	Wedding PM-10 Sampler
Total Suspended Particulates (TSP)	Reference Method (Hi-Volume) 24-Hour sampling (6th-day)

Table 5.1-5 Plutonium-239 and -240 Activity Concentrations in Onsite Ambient Air at Selected Locations During 1988[a]

Station	Number of Analyses	Volume (X 1000m^3)[d]	Concentration[b] (x 10^{-15} µCi/ml)[c] C_{min}	C_{max}	Standard Deviation C_{mean}	Percent of DCG[e] (C_{mean})	(C_{mean})
S-5	25	331	0.054	1.389	0.389	0.357	1.95
S-6	26	344	0.027	0.460	0.149	0.111	0.75
S-7	26	328	0.045	1.171	0.515	0.369	2.58
S-8	26	418	0.114	1.246	0.710	0.366	3.55
S-9	26	376	0.205	1.179	0.641	0.286	3.21
S-6[f]	1	11	NA[g]	NA	0.059	NA	0.30
S-7	1	12	NA	NA	0.664	NA	3.32
S-8	1	17	NA	NA	2.129	NA	10.65
S-9	1	12	NA	NA	1.281	NA	6.41

a. Air-sampling stations S-5, S-6, S-7, S-8, and S-9 are located in areas where the potential for elevated airborne radioactivty is greatest.

b. Concentrations reflect monthly composites of biweekly station concentrations. C_{min} = minimum composited concentration; C_{max} = maximum composited concentration; C_{mean} = mean composited concentration.

c. To obtain the proper concentration, multiply the numbers listed in the table by 1 x 10^{-15} µCi/ml. For example, the mean concentration at S-5 was 0.389 x 10^{-15} µCi/ml.

d. To obtain the proper volume, multiply the numbers listed in the table by 1000 m^3. For example, the air volume sampled at S-5 was 331,000 m^3.

e. The interim standard calculated Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public are applicable for offsite locations. All locations in this table are on Rocky Flats Plant property. The DCGs for the public are presented here for comparison purposes only.

f. Samples from stations S-6 (taken 8/9/88 to 8/23/88), S-7 (taken 4/19/88 to 5/3/88), S-8 (taken 11/29/88 to 12/13/88), and S-9 (taken 8/23/88 to 9/6/88) exceeded the screening guide to 10 x 10^{-15} µCi/ml total long-lived alpha activity. Specific plutonium analyses were performed on these samples. The results of these analyses are included for completeness.

g. NA = Not applicable.

Table 5.1-6 Onsite Ambient Air Sampler Plutonium Concentrations During 1990[a,b]

Station	Number of Samples	Concentration ($\times 10^{-15}$ µCi/ml)[c] Cminimum	C maximum	C mean	Standard Deviation (C standard)	Percent of DCG[d] (C mean)
S-1	21	0.000	3.057	0.948	0.892	4.740
S-2	13	0.003	0.024	0.007	0.007	0.037
S-3	16	0.000	0.010	0.003	0.001	0.014
S-4	17	0.001	0.181	0.022	0.050	0.110
S-5	24	0.004	0.453	0.099	0.123	0.496
S-6	24	0.013	0.482	0.127	0.144	0.637
S-7	24	0.010	0.670	0.118	0.180	0.588
S-8	25	0.024	0.108	0.061	0.033	0.305
S-9	24	0.033	0.328	0.107	0.094	0.535
S-10	17	0.002	0.016	0.006	0.004	0.028
S-11	17	0.000	0.008	0.005	0.003	0.024
S-12	17	0.002	0.023	0.013	0.007	0.063
S-13	17	0.001	0.008	0.004	0.003	0.018
S-14	17	0.000	0.006	0.002	0.002	0.011
S-15*	15	-0.001	0.028	0.004	0.008	0.021
S-16	17	-0.001	0.005	0.002	0.002	0.011
S-17	17	0.005	0.022	0.011	0.005	0.053
S-18*	16	0.011	0.069	0.035	0.020	0.177
S-19	17	0.010	0.092	0.028	0.023	0.142
S-20	17	0.004	0.033	0.016	0.008	0.080
S-21	17	0.004	0.018	0.009	0.005	0.045
S-22	17	0.001	0.009	0.004	0.002	0.020
S-23	16	0.001	0.006	0.003	0.002	0.015
S-24	17	-0.002	0.010	0.002	0.003	0.012
S-8B*	13	0.051	0.356	0.161	0.123	0.806
Overall	452	-0.002	3.057	0.072	0.070	0.360

a. Data provided in this table are based on various periods of sampling. The locations not marked with an asterisk are calculated on a 12-month basis. The other locations are calculated using less than 12 months of data due to mechanical malfunctions, incomplete laboratory analyses, or the installation of a new sampler (S-8B) that has not been in service for a complete year.

b. Isotope-specific analyses were reported only for locations S-5 through S-9 before 1990. These five samplers are the only onsite locations included in the 5-year trending portion of this report.

c. Concentrations reflect monthly composites of biweekly station concentrations; C minimum - minimum composited concentration; C maximum = maximum composited concentration; C mean = mean composited concentration.

d. The DOE Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public is 20 x 10^{-15} µCi/ml. Protection standards for members of the public are applicable for offsite locations. All locations in this table are on RFP property. DCGs for the public are presented here for comparison purposes only.

Table 5.1-7 Ambient Air Quality Data for Nonradioactive Particulates

Total Suspended Particulates	$\mu g/m^3$	
Total Number of Samples[a]		56.0
Total Number of Samples[b]		59.0
Annual Geometric Mean[a]		31.4
Annual Geometric Mean[b]		27.7
Standard Deviation[a]		20.3
Standard Deviation[b]		18.2
Observed 24-Hour Maximum[a]	134.4	
Observed 24-Hour Maximum[b]	119.0	
Second Highest Maximum[a]		74.0
Second Highest Maximum[b]		69.0
Lowest Observed Value[a]		8.0
Lowest Observed Value[b]		2.9
Respirable Particulates (PM-10)		
Total Number of Samples[c]		45.0
Total Number of Samples[d]		49.0
Annual Arithmetic Mean[c]		9.8
Annual Arithmetic Mean[d]		11.2
Observed 24-Hour Maximum[c]	26.0	
Observed 24-Hour Maximum[d]	29.7	
Second Highest Maximum[c]		19.0
Second Highest Maximum[d]		26.0

a. Primary ambient air TSP particulate sampler; reporting unit.
b. Collocated duplicate TSP sampler.
c. Primary ambient air PM-10 sampler.
d. Collocated duplicate PM-10 sampler.

Table 5.2-1

Data Objectives and Decisions

OBJECTIVE	RFI/RI ACTIVITY	DECISIONS
Evaluate the potential presence or absence of contaminants in the site's air, surface water, soils, subsoils, and groundwater.	Review site historical records and available contaminant source and distribution data.	Determine the applicable regulatory framework in conformance with the IAG.
Determine the demographic setting of the site and establish the site's relationship with surrounding population centers.	Collect qualitative and quantitative information describing the demographic setting, community interest groups and their attitudes towards the site.	What level of community relations involvement is appropriate in the early stages of the RFI/RI process, and how will this involvement be incorporated into other ongoing or planned community relations efforts.
Characterize the environmental setting of the site and define the mechanisms for contaminant transport.	Collect environmental samples (air, surface water, soils, subsoils, and groundwater), perform analyses, and conduct field tests to quantify and describe the physical nature of the site and to define the mechanisms governing contaminant transport.	Adjust the level of detail necessary to adequately describe the site as investigative activities progress.
Define contaminant concentrations and the extent of contamination.	Analyze sample data to define concentration gradients.	Prioritize contamination sources and transport mechanisms for future studies.
Assess the risks the site poses to human health and the environment.	Compare contamination data to existing health standards and perform a risk assessment.	Prioritize sources that may pose a threat to human health and the environment. Assess what level of community relations is appropriate.
Identify applicable remedial alternatives based upon the physical properties of the contaminants, the media in which they occur, and the migration and exposure pathways.	Review literature on available remedial technologies and their application. Use RFI/RI data to select technology that is compatible with the site and risk assessment requirements.	What resources can be shared between similar remedial actions at other operable units.

Table 5.2-2

Data Uses, Data Needs and Analytical/Field Quality

DATA USE	DATA TYPE	ANALYTICAL LEVEL	QA/QC METHODS
Site Characterization Risk Assessment Evaluation of Remedial Alternatives Engineering Design Alternatives Monitoring During Remedial Action Correlation of Contamination to Responsible Party(s)	Groundwater samples are needed to determine concentrations of TCL volatiles, TCL semi volatiles, TAL metals, nitrates, total plutonium, total uranium tritium and gross alpha and gross beta activity.	Level IV, EPA CLP Protocol (for analytes other than radiochemicals). Level V for radiochemical analytes.	Duplicates, matrix spikes and matrix spike duplicates will be collected from wells that produce enough water to collect the required suites of analytes without dewatering. Laboratory QA/QC will be in accordance with CLP protocol.
Site Characterization Health and Safety Risk Assessment Evaluation of Remedial Alternatives Engineering Design Alternatives	Composite soil samples from boreholes are needed to determine the concentration and distribution of organic and inorganic chemicals, and radioisotopes in the alluvium.	Level III, offsite laboratory for analytes other than radiochemicals. Level V for radiochemical analysis.	Duplicates for every 10 samples. Method blanks for each suite of samples sent off-site for analysis. Laboratory QA/QC will be in accordance with the GRRASP.
Site Characterization	Real time soil-gas surveys are needed to identify areas contaminated with organic chemicals. Surveys will be conducted using sampling grids.	Level II, field portable GC/MS or GC equipment.	GC field calibration after every 10 sample analyses. Field duplicates for every 10 samples. Method blanks for each operating day.

TABLE 5.2-2
DATA USES, DATA NEEDS AND ANALYTICAL/FIELD QUALITY (page 2)

DATA USE	DATA TYPE	ANALYTICAL LEVEL	QA/QC METHODS
Site Characterization Health and Safety Risk Assessment	Surface scrape samples and surface wipe samples are needed to identify areas exhibiting radiological contamination.	Level III, offsite laboratory for analytes other than radiochemicals. Level V for radiochemical analysis.	Duplicates for every 10 samples. Method blanks for each suite of samples sent for analysis. Laboratory QA/QC will be in accordance with the GRRASP.
Site Characterization Health and Safety	Radiological surveys are needed to identify areas with elevated activity levels in IHSSs that are suspected to be contaminated with radioisotopes.	Level I, field portable detectors (HPGe, GM and FIDDLER).	Performance testing as specified by EG&G Radiation Instrumentation.

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 1)

RADIATION SURVEY
IHSSs 123.1, 123.2, 125, 127, 144, 146.1 - 146.6, 149, 150.1 - 150.8, 159, 163.1, 163.2, 172, and 173

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Beta/Gamma radiation, Alpha radiation	Survey entire area on a grid[1]. Areas exhibiting elevated activity levels will be surveyed on a grid spacing of two feet. If surfacing is present, surface scrape samples will be collected.	OPS,EMRG.1.1* OPS,EMRG.1.2* OPS,EMRG.3.2* Operating Procedures for the HPGe will be developed prior to field use.	HPGe on sites large enough to accommodate the units radius of investigation, Geiger-Mueller (GM) shielded pancake detector, and side shielded FIDDLER.	Beta/Gamma - 5,000 dpm/100cm^2 (removable plus fixed sources). Alpha - 300dpm/100cm^2 (removable plus fixed sources).

[1] Radiation Survey Grid Spacing - IHSS 144 = 15 feet; IHSSs 123.2, 150.1 - 150.8, 163.1 - 163.2 and 173 = 25 feet; IHSSs 123.1, 125, 127, 144, 146.1-146.6, 149, and 159 = 10 feet; IHSS 172 = 50 feet (compressed to 5 feet within 50 feet of stopping or unloading areas).

* EG&G, 1991b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 2)

SURFACE SCRAPE RADIOCHEMISTRY SAMPLING
IHSSs 118.1, 118.2, 125*, 126.1, 126.2, 127, 135, 137, 138, 146.1 - 146.6, 149, 150.1 - 150.8, 159, 163.1 and 163.2

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Total plutonium[1,2,3,4,6,7,8] Total Uranium[1,2,3,4] Uranium-233/234[6,7,8] Uranium-235[6,7,8] Uranium-238[6,7,8] Total americium[1,2,3,4,6,7,8] Tritium[1,6,7] Gross alpha[1,2,3,4,6,7,8] Gross beta[1,2,3,4,6,7,8] Beryllium[2,3,6,7,] Total chromium[5,6,7] Nitrate[2,3,4,6,7] Sodium[6] Sulfate[6] TCL volatiles[2,3] TAL metals[4,6,7]	Two inch surface scrapes will be collected at locations where surfacing renders routine radiation survey methods ineffective, and at each borehole location.	OPS,GT.8.**	GRRASP methods.	Total Plutonium - .03 pCi/g Uranium-233 & 234 - .03 pCi/g Uranium-235 & 236 - .03 pCi/g Americium - .02 pCi/g Tritium - 400 pCi/L Gross Beta - 10 pCi/g Gross Alpha - 4 pCi/g Beryllium - 1.0 mg/Kg Total chromium - 2.0 mg/Kg Nitrate - 0.1 mg/Kg Sodium - 2,000 mg/Kg Sulfate - 10.0 mg/Kg TAL metals - EPA CLP Detection Limits.

[1] Analysis required for IHSSs 118.1 and 118.2

[2] Analysis required for IHSSs 125

[3] Analysis required for IHSSs 126.1 and 126.2

[4] Analysis required for IHSSs 127

[5] Analysis required for IHSSs 135, 137 and 138

[6] Analysis required for IHSSs 146.1 - 146.6 and 150.1 - 150.8

[7] Analysis required for IHSSs 149 and 159

[8] Analysis required for IHSSs 163.1 and 163.2

* If surfacing was placed after the spills occurred, a 2" surface scrape shall be collected.

** EG&G, 1992b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 3)

SOIL - GAS SAMPLING
IHSSs 118.1, 118.2 and 151

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
1,1,1 Trichloroethane Carbon tetrachloride Methylethylketone Dichloromethane Perchloroethene Trichloroethene Benzene[1] Toluene[1] Xylene[1] Analytical peaks for compounds not calibrated for on the GC.	Sampling grid with intervals of 10 feet. Sample intervals may be compressed as field conditions indicate.	OPS,GT.9,* OPS,GT.19*	Field portable GC calibrated for sample parameters shown in column 1.	Perchloroethene - 5ug/L 1,1,1 Trichloroethane - 5ug/L Carbon tetrachloride - 5ug/L Methylethylketone - 10ug/L Dichloromethane - 5ug/L Trichloroethene - 5ug/L Benzene - 5ug/L Toluene - 5ug/L Xylenes - 5ug/L

[1] Analysis required for IHSS 151 only.
* EG&G 1992b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 4)

BOREHOLE SOIL SAMPLING
IHSSs - 118.1, 118.2, 123.1, 123.2, 125, 126.1, 126.2, 127, 132, 135, 137, 138, 144, 146.1 - 146.6, 149, 150.1 -150.8, 151, 159, 163.1, 163.2 and 172

Contaminants of Concern	Sampling Task (For details see Table 5.2-4)	EG&G Operating Procedures	Analytical Method	Detection Limit
Total plutonium[2,3,4,5,9,10,11,12,13,14] Total Uranium[2,3,4,5] Uranium-233/234[7,10,11,12,13,14] Uranium-235[10,11,12,13,14] Uranium-238[10,11,12,13,14] Total americium[2,3,4,5,7,9,10,11,12,13,14] Gross alpha[2,3,4,5,9,10,11,12,13,14] Gross beta[2,3,4,5,9,10,11,12,13,14] Tritium[9,10,11,12] Beryllium[2,3,5,9,10,11,12,14] Total chromium[6,7,8,9,10,11,12] Phosphates[6,7,8] Fluorides[2] Nitrate[2,3,4,9,10,11,12,13] Sodium[10] Sulfate[9,10] TAL metals[9,10,11,12,13] TCL semi-volatiles[10,14] TCL volatiles[1,2,3,10,11,12,14]	Borehole numbers, spacing, depth, composite intervals and special sample collection procedures are listed in Table 11.3 Attachment a.	OPS,GT.2*	Calibrated laboratory GC/MS, GRRASP methods. EPA 340.2, 353.2, 365.1 and 375.3 for fluorides, nitrate, phosphates and sulfate respectively.	Total Plutonium - .03 pCi/g Uranium-233 & 234 - .03 pCi/g Uranium-235 & 236 - .03 pCi/g Americium - .02 pCi/g Tritium - 400 pCi/L Gross Beta - 10 pCi/g Gross Alpha - 4 pCi/g Beryllium - 1.0 mg/Kg Total chromium - 2.0 mg/Kg Phosphate - 0.1 mg/Kg Fluorides - 1.0 mg/Kg Nitrate - 0.1 mg/Kg Sodium - 2,000 mg/Kg Sulfate - 10.0 mg/Kg TAL metals - EPA CLP Detection Limits. TCL semi-volatiles - EPA CLP Detection Limits. TCL volatiles - EPA CLP Detection Limits.

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 5)

[1] Analysis required for IHSSs 118.1, 118.2 (TCL volatiles required only for discrete samples from every other 2 foot interval) and IHSS 151.
[2] Analysis required for IHSSs 123.1 and 123.2 (TCL volatiles required only for discrete samples from every other 2 foot interval)
[3] Analysis required for IHSSs 125, 126.1 and 126.2 (TCL volatiles required only for discrete samples from every other 2 foot interval)
[4] Analysis required for IHSS 127
[5] Analysis required for IHSS 132
[6] Analysis required for IHSSs 135
[7] Analysis required for IHSS 137
[8] Analysis required for IHSS 138
[9] Analysis required for IHSS 144
[10] Analysis required for IHSSs 146.1 - 146.6 and 150.1 - 150.8
[11] Analysis required for IHSS 149
[12] Analysis required for IHSS 159
[13] Analysis required for IHSS 163.1 - 163.2
[14] Analysis required for IHSS 172
*EG&G, 1992b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 6)

SHALLOW BOREHOLE SAMPLING
IHSSs 139.1 and 139.2

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Sodium Potassium Fluoride Nitrate	Samples will be collected from soil borings six inches in depth. A sampling grid with 15 foot centers will be used.	OPS,GT.08*	GRRASP, CLP protocol and EPA 340.2 (Fluorides)	Sodium - 2,000 mg/Kg Potassium - 2,000 mg/Kg Fluoride - 0.1 mg/Kg Nitrate - 0.1 mg/Kg

*EG&G, 1992b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 7)

ALLUVIAL GROUNDWATER SAMPLING
IHSSs 125, 126.1 and 126.2

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Total plutonium Total americium Total uranium Tritium Gross alpha Gross beta Nitrate Fluorides TCL volatiles TCL semi-volatiles TAL metals	Samples will be collected quarterly from two wells constructed immediately downgradient of IHSS 125, 126.1 & 126.2 and spaced approximately 10 feet apart.	OPS,GW.1* OPS,GW.5* and OPS,GW.6*	GRRASP, CLP protocol.	Total plutonium - .03 pCi/L Total americium - .01 pCi/L Total uranium - .03 pCi/L Tritium - 400 pCi/L Gross alpha - 2 pCi/L Gross beta - 4 pCi/L Nitrate - 1 mg/L Fluorides - 0.1 mg/Kg TCL volatiles - EPA CLP Detection Limits TCL semi-volatiles - EPA CLP Detection Limits TAL metals - EPA CLP Detection Limits

* EG&G, 1991c
All soil samples collected from the saturated zone will be sampled for americium

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
118.1 & 118.2	Not applicable	4 boreholes transecting the IHSS 118.1 area with one random sample to be located after completing the soil-gas survey. 2 boreholes transecting IHSS 118.2 with one random sample to be located after completion of the soil-gas survey.	Top of the saturated zone or 6 feet into weathered bedrock whichever is shallower.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
123.1 & 123.2	Approximately 30 foot spacing adjacent to the vaults, and 50 foot spacing along the route of the old process waste line.	4 boreholes will be located immediately surrounding each of the vaults.	10 feet below the base of the each vault and the base of the old process waste line.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 8)

ASPHALT SAMPLING
IHSS 172

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Total plutonium Total americium Uranium-233/234 Uranium-235 Uranium-238 Beryllium Gross alpha Gross beta TAL metals	Samples of asphalt will be collected if the results of the radiation survey to be conducted for this site indicate that contamination in excess of DOE limits for uncontrolled areas is present.	OPS,GT.08* to be modified by document change notice.	GRRASP, CLP protocol.	Total plutonium - .03 pCi/g Total americium - .02 pCi/g Uranium-233/234 - .3 pCi/g Uranium-235 - .3 pCi/g Uranium-236 - .3 pCi/g Gross alpha - 2 pCi/L Gross beta - 4 pCi/L Beryllium - 1.0 mg/Kg TAL metals - EPA CLP Detection Limits

*EG&G, 1992b

TABLE 5.2-3
DATA QUALITY OBJECTIVES SUMMARY (page 9)

SURFACE WIPE SAMPLING AND GRAB SAMPLES
IHSS 173

Contaminants of Concern	Sampling Task	EG&G Operating Procedure	Analytical Method	Detection Limit
Total plutonium Total Uranium Total americium Total cesium Total Strontium Tritium Beryllium Gross alpha Gross beta	Based upon the results of the radiation survey, surface wipe samples will be collected from the area immediately surrounding building 991 and to the south and west of building 991. Surfaces that are covered by asphalt, concrete or similar structural surfacing will be wipe sampled. Surface soil grab samples will be collected at locations that are not surfaced.	OPS - EMRG, 3.1, R.0*	GRRASP, CLP protocol.	Total plutonium - .03 pCi/g Total uranium - .03 pCi/g Total americium -.02 pCi/g Total cesium - .01 pCi/g Tritium - 400 pCi/g Gross alpha - 2 pCi/L Gross beta - 4 pCi/L Beryllium - 1.0 mg/Kg

* EG&G 1991a

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
118.1 & 118.2	Not applicable	4 boreholes transecting the IHSS 118.1 area with one random sample to be located after completing the soil-gas survey. 2 boreholes transecting IHSS 118.2 with one random sample to be located after completion of the soil-gas survey.	Top of the saturated zone or 6 feet into weathered bedrock whichever is shallower.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
123.1 & 123.2	Approximately 30 foot spacing adjacent to the vaults, and 50 foot spacing along the route of the old process waste line.	4 boreholes will be located immediately surrounding each of the vaults.	10 feet below the base of the each vault and the base of the old process waste line.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 2)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
125	Approximately 10 foot spacing on the northeast side of tanks only. Buildings and a loading dock restrict access on other sides of the tank.	2 boreholes will be located hydraulically downgradient of the tanks.	10 feet below the base of the tank.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples. Both boreholes will be converted to groundwater monitoring wells.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 3)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
126.1 & 126.2	Approximately 10 feet apart on the northeast side of the tanks.	2 boreholes will be located immediately downgradient of each of the tanks .	10 feet below the base of the tanks.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples. Both boreholes will be converted to groundwater monitoring wells.
127	20 foot spacing.	6 boreholes 4 additional boreholes will be located along the route of the pipeline between buildings 774 and 995.	10 feet below the pipe invert carrying waste between buildings 995 and 774 or 6 feet into weathered bedrock whichever is shallower.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Matric potential samples will be collected at 2 foot intervals.
132	Borehole spacing will be determined based upon the tank spacing and configuration.	The number of boreholes will be determined based upon the tank spacing and configuration.	10 feet below the bottom of the tank or 6 feet into weathered bedrock whichever results in a greater total depth.	6 foot composites	Geologic logs will be prepared over the entire depth of the boring.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 4)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
135	25 foot spacing	30 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
137	20 foot spacing	10 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
138	25 foot spacing	9 boreholes	6 feet	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for total chromium and phosphates.	Geologic logs will be prepared over the entire depth of the boring.
139.1 & 139.2	15 foot spacing	20 boreholes each	6 inches	Not applicable	Geologic logs will be prepared over the entire depth of the boring.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 5)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
144	Approximately 10 foot spacing along the route of the sewer line, and 30 foot spacing on the affected hillside.	2 boreholes adjacent to the sewer line. 4 boreholes located on the affected hillside.	5 feet below the pipe invert or 6 feet into weathered rock. 6 feet into weathered rock.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled.	Geologic logs will be prepared over the entire depth of the boring.
146.1 - 146.6	Approximately 30 foot spacing.	6 boreholes located immediately adjacent to the tanks.	10 feet below the tank inverts.	6 foot composites for all of the boreholes. For 3 of the 6 boreholes, after the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and sampled for TCL volatiles and semi-volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 6)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
149	50 foot spacing	11 boreholes	5 feet below the invert of the waste lines or 6 feet into weathered bedrock.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 7)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
150.1 - 150.8	150.1 - 50 foot spacing	9 boreholes	6 feet into weathered bedrock	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
	150.2 - 50 foot spacing	20 boreholes			
	150.3 - 2 rows of 3 boreholes	6 boreholes			
	150.4 - 2 rows of 4 boreholes	8 boreholes			
	150.5 - 75 foot spacing	10 boreholes			
	150.6 - 2 rows of 4 boreholes	8 boreholes			
	150.7 - 50 foot spacing	10 boreholes			
	150.8 - 40 foot between boreholes on a linear transect	3 boreholes			

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 8)

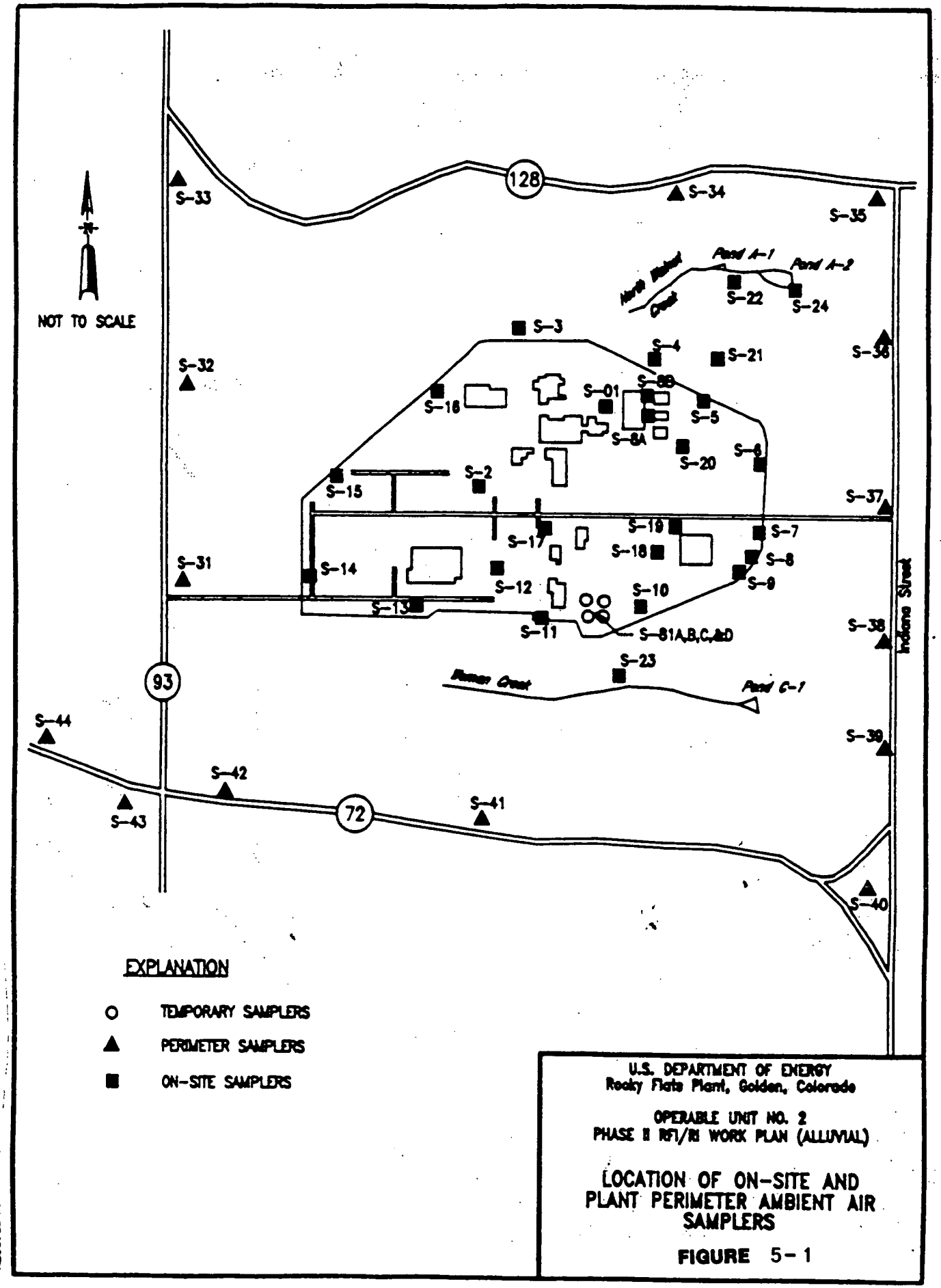
BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
151	Not applicable	4 boreholes spaced uniformly around the tank and immediately adjacent to it.	5 feet below the bottom of the tank or 6 feet into weathered bedrock whichever is greater.	After the first foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.
159	20 foot spacing	7 boreholes	5 feet below the invert of the waste lines.	After the first 2 foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled and analyzed for TCL volatiles. Six foot composites will be collected for analysis of inorganic analytes.	Geologic logs will be prepared over the entire depth of the boring. Matric potential samples will be collected at 2 foot intervals. BAT samples will be collected based upon the results of the matric potential samples.

TABLE 5.2-4
BOREHOLE SOIL SAMPLING DETAILS (page 9)

BOREHOLE SOIL SAMPLING TASKS

IHSS Number	Grid Spacing	Number of Boreholes	Borehole Depth	Sample Interval	Additional Sampling Criteria
163.1 & 163.2	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	10 feet	After the first foot interval is drilled, 1 discrete sample shall be collected from every other 2 foot interval drilled.	Geologic logs will be prepared over the entire depth of the boring.
172	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	.5 feet	.5 foot composites	None
173	To be based upon the results of the radiation survey.	To be determined from the radiation survey.	Surface grab sample.	Not Applicable	None



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 2
PHASE II RFI/RI WORK PLAN (ALLUVIAL)

LOCATION OF ON-SITE AND PLANT PERIMETER AMBIENT AIR SAMPLERS

FIGURE 5-1

R3307JA/CP-071191

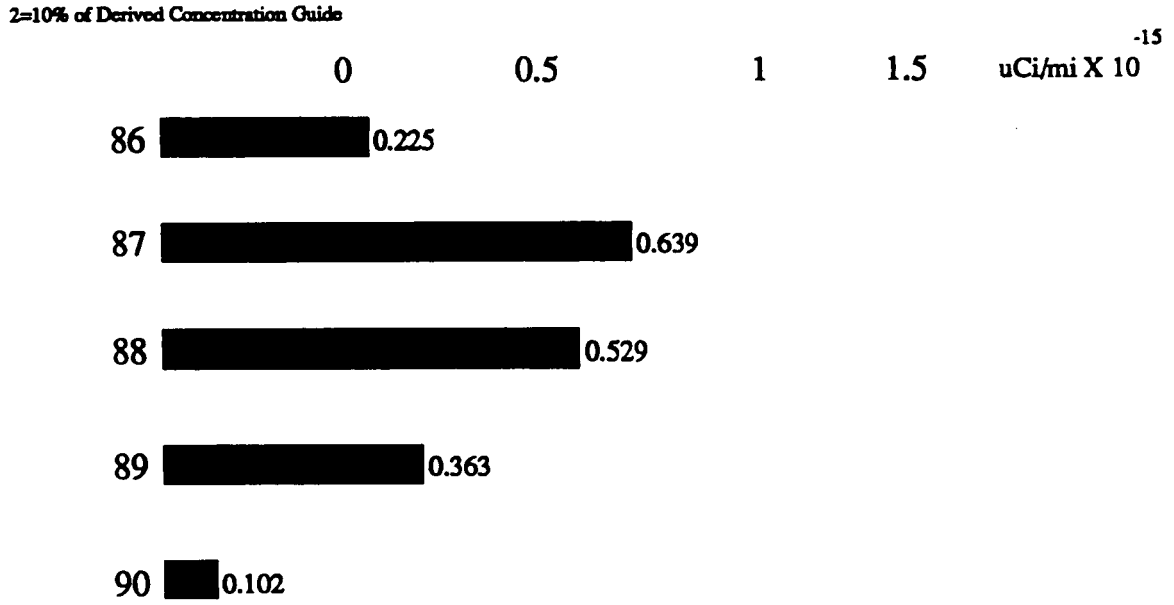


Figure 5-2. Plutonium-239,-240 Onsite Concentrations, 1986-1990

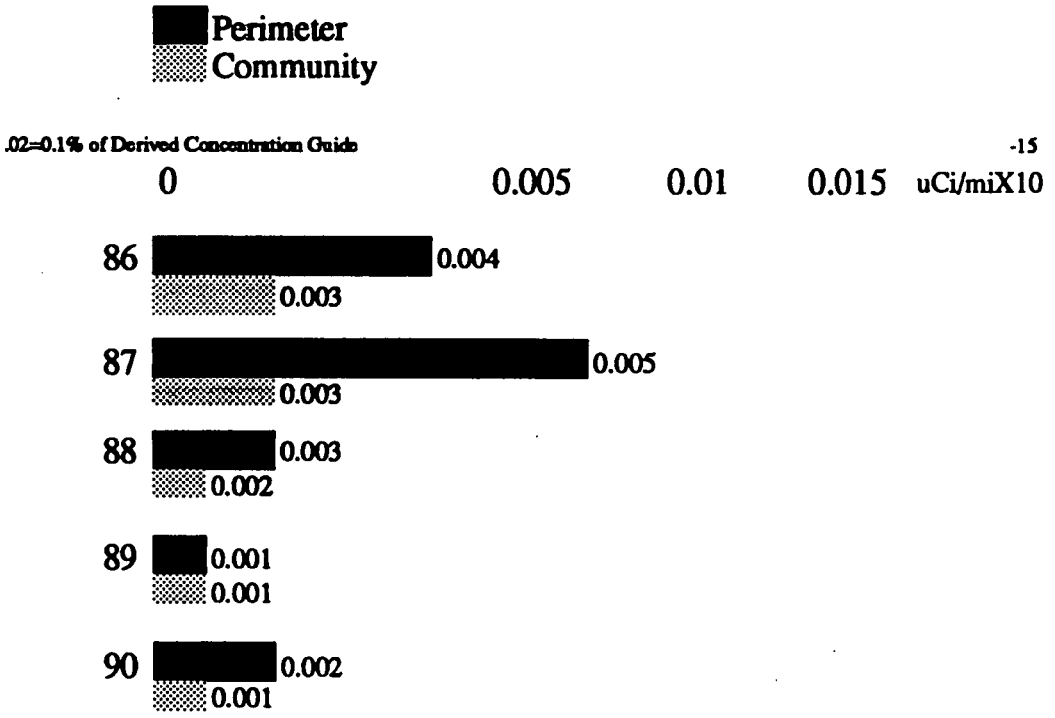
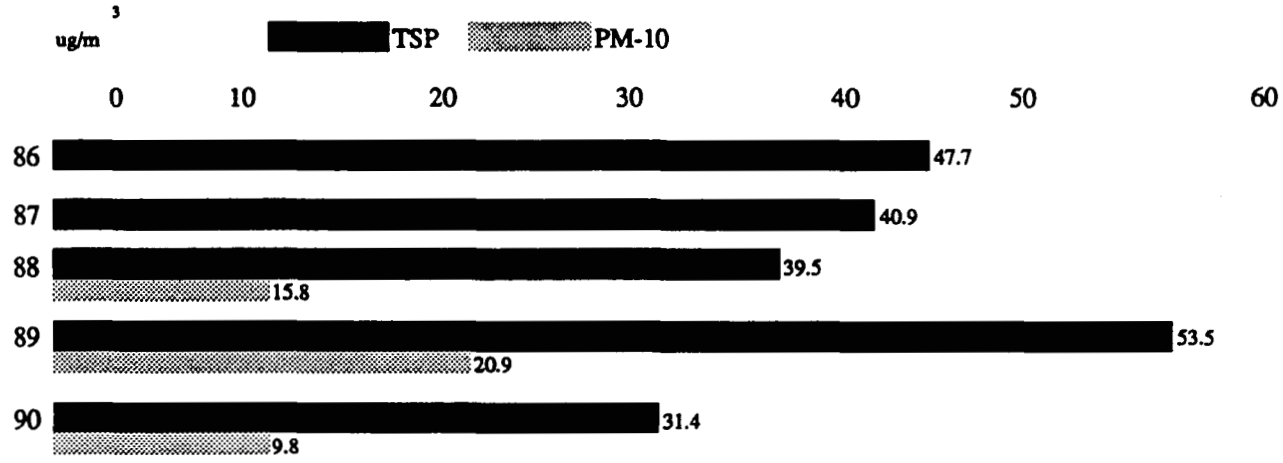


Figure 5-3. Plutonium-239,-240 Perimeter and Community Concentrations, 1986-1990



50=TSP (NAAQS) 60=PM-10 (NAAQS)

Figure 5-4. TSP and PM-10 Results, 1988-1990

6.0 FIELD SAMPLING AND ANALYSIS PLAN

6.1 SAMPLING RATIONALE AND OBJECTIVES

Environmental samples will be collected to achieve the data objectives stated in this Work Plan. Sampling activities will be staged, allowing the initial stages to provide information that can be used to direct and refine the methods used in subsequent stages. Technical Memoranda will be prepared to summarize and interpret the information that was collected after each stage of investigation is completed. Based upon an evaluation of the data, the Technical Memoranda may recommend changes in the scope and subsequent staged approach of the Work Plan.

The rationale used to select the contaminants of concern specified in Section 5 of this Work Plan (Table 5.2-3) took into account the following considerations:

- The operating history of the IHSS suggests that there is a strong probability that the contaminant was released into the environment;
- The physical and chemical properties of the contaminant suggest that it is persistent once it has been released into the environment;
- The principal contaminants of concern at each IHSS are identified in Table 5 of the IAG (Appendix A); and are also included in the draft HRR (DOE, 1992) and recent updates completed by Doty and Associates (Appendix B).
- Rocky Flats Environmental Database (RFEDs) analytical data that are applicable to OU8 indicate the presence of the contaminant in quantities above the maximum background concentration for RFP.

Coordination of field sampling activities between adjacent and contiguous Operable Units will be done to conserve resources and minimize field mobilization costs. Such coordination will permit efficient and thorough evaluation of current conditions and the nature and extent of contamination for each IHSS in OU8.

6.1.1 Surficial Soil

The rational for surficial soils sampling is based on a lack of data which would indicate whether contamination of the soils and surficial materials from particular IHSSs has occurred, and/or would indicate the nature and extent of said contamination.

Within OU 8 there are several IHSSs in which contamination of the surficial materials may have occurred. This assumption is based on the volume of the release, response to said release and the chemical character of the contaminant, including the potential for buffering or the likelihood that the contaminant would still be present in significant amounts. Insufficient data due to the lack of validating the current data and/or absence of analysis does not allow an adequate characterization of the individual IHSSs. In addition, variable geologic conditions exist at OU8 within the surficial materials and shallow bedrock which may complicate the expected flow paths of potential contaminants.

Surficial materials sampling can establish the presents and nature and extent of contaminants. It is likely that in most cases surficial materials sampling will also be able to determine the source areas, except in some areas with overlapping source areas. Additional data regarding the geochemical and physical characterization of the surficial materials at OU8 is needed and a preliminary step towards this goal can be accomplished by implementing the surface soils sampling plan as set forth in Section 6.

6.1.2 Surface Water and Sediment

The contaminants released to the environment from the IHSSs were often spilled onto the ground or parking lot surfaces which would allow the precipitation the wash the constituents into the drainageways downstream of the IHSS. The location of the existing surface-water and sediment monitoring sites are in places that collect large land areas, and therefore, numerous IHSSs.

Additional surface-water and sediment sampling is required to isolate runoff from individual contamination sources.

Many of the buildings within the OU8 boundary have perimeter footing underdrains. It is suspected that groundwater in the vicinity of these underdrains is being collected and discharged into the storm sewer (or sanitary sewer) systems and then being discharged into the open drainageways. The existence of underdrains and the location of the surface discharge points is necessary to determine the interaction between the groundwater and surface water within OU8.

A staged approach to surface-water and sediment monitoring is recommended in Section 6. This approach would analyze existing data, collect additional data where needed, and analyze the additional data before making decisions regarding the continuation of field sampling. It is unclear at this time if a direct connection between the groundwater and surface-water systems can be established via the existing underdrains.

6.1.3 Groundwater

The rationale for groundwater sampling is based on a lack of downgradient groundwater monitoring well data which would indicate whether contamination of the groundwater from a particular IHSS has occurred.

Within OU8 there are several IHSSs in which contamination of the groundwater may have occurred. This is based on the volume of the release, suspected pathway and the chemical character of the contaminant, including the potential for dilution or the likelihood that the contaminant would still be present in significant amounts. Insufficient data due to the absence of downgradient groundwater monitoring wells does not allow an adequate characterization of the individual IHSSs. In addition, variable geological conditions exist at OU8 within surficial materials and shallow bedrock which may complicate the expected flow paths of potential contaminants, most especially the presence of footings drains and outcropping and subcropping

Arapahoe sandstones. The presence of drainages also allow contaminants to leave the groundwater system through seeps along valley walls.

Groundwater monitoring will establish the presence of a contaminant, but it cannot establish the likely source, espcially in an area with overlapping source areas, unless the hydrogeological conditions are understood and well represented in a conceptual model. Additional data regarding the geochemical and physical characterization of the groundwater system at OU8 is needed and a preliminary step towards this goal can be accomplished by implementing the groundwater sampling plan as set forth in Section

6.1.4 Rationale for Specifying and Collecting Additional Air Quality Data

Whether defining baseline conditions or monitoring field operations, monitoring is the primary approach used to characterize and verify area air emissions. Air monitoring technologies can be organized into the following four generic categories:

1. Direct Emissions Measurement - This method is preferred for investigating an area's volatile soil gases. Area emissions measurement generally involves isolating a small section of soil surface with an airtight enclosure and measuring the concentration of vapor resulting in the headspace. Alternatively, soil gas plume boundaries and concentrations can be quickly defined by inserting an extraction probe into site soils and analyzing collected soil gases. These concentration measurements can be used to calculate an emission flux, which can then be related to an emissions rate for the area source. Although neither method considers local meteorological influences other than at the time of sampling, the acquired data can be used to develop estimates of volatile organic emissions to air. Neither technique allows evaluation of particulate emissions to air.

2. Indirect Emission Measurement - This method involves measuring the atmospheric concentration of the emitted species (volatile and/or particulate matter) and equating this data to an estimated emission rate. All techniques involve clusters of ambient air samplers positioned close to the emission source. Precise monitoring schemes require individual monitors be placed in a vertical array at each monitoring station. Screening measurements can be made upwind, downwind, and/or directly above the site using real-time instruments. Downwind measurements can be corrected for instrument bias and upwind interferences. False negatives may occur if species concentrations are below instrument minimum detection levels. These methods are appropriate for assessment of airborne total suspended particulate/respiratory particulate concentrations.

3. Air Monitoring/Modeling - With this method of monitoring, technologies that measure ambient air concentration are combined with air dispersion algorithms to calculate the area source emission rate. These models usually provide air concentration information at a distance further downwind than indirect measurement data, and they do not distinguish between multiple units within a combined site.

4. Predictive Emissions Models - With this method, emission rates for a wide variety of waste types can be predicted provided fairly detailed information is available for model input. Assumptions concerning the theoretical and empirical relationships of individual contaminant mobility are applied to known site-specific factors to derive estimates of individual contaminant emissions rates. These rates are then added to determine the overall emission rate from the site.

Information currently available for OU8 does not support an air pathway assessment for individual IHSS sites or the OU as a whole. This limited data precludes the application of predictive emissions models in estimating individual site emissions rates. Similarly, dispersion

modeling methodologies do not lend themselves to individual IHSS site air pathway analysis. However, the existing RAAMP monitoring can continue to be used in the acquisition of airborne particulate information on multiple RFP units, including OU8 IHSS sites.

High-volume samplers are proposed for this application because they provide a high particulate loading on the filters. Heavily-loaded filters provide greater detectability than lightly-loaded filters. Filters in the low-volume total suspended particulate samplers are often so lightly loaded that concentrations of many radionuclides fall below detection limits. The high-volume samplers sample almost twice as large a volume of air in 24 hours (2448 m^3). The high-volume filters, therefore, should have more contaminant mass and better detectability than the low-volume filters. Additionally, EPA guidelines specify that total suspended particulates should be sampled with a high-volume sampler (EPA, 1985) for analysis of inorganic compounds.

6.2 PHASE I RFI/RI OBJECTIVE

This Field Sampling and Analysis Plan (FSAP) provides the rationale, and methodology for performing a Phase I RFI/RI at IHSSs located at the RFP. The RFI/RI will address 38 separate IHSSs which have been identified as potential or confirmed contaminant sources in the IAG.

The general purpose of the Phase I RFI/RI is to characterize the nature and extent of contamination, to provide the data needed to support a risk assessment and to aid in the selection of remedial alternatives. Specific objectives of the OU 8 RFI/RI are to:

- Confirm or refute historical information to accurately locate and describe release mechanisms and contaminants at each of the IHSSs;
- Identify each of the chemical and radiochemical constituents that are present at each of the IHSSs;
- Define the lateral and vertical extent of contamination at each IHSS;
- Supplement and refine the existing body of knowledge regarding the environmental characteristics of the IHSSs including transport mechanisms;

- Evaluate potential risks posed to the public health and the environment; and
- Develop sufficient data regarding the conditions at the IHSSs and nature and extent of contaminants present to enable evaluation and selection of remedial alternatives.

The FSAP was developed in coordination with the DQOs set forth in this Work Plan, and will be capable of providing quality data that are compatible with other RFP investigations that use the same standard methods specified in this Work Plan.

6.3 INTEGRATION WITH RFP STANDARD OPERATING PROCEDURES

EG&G Rocky Flats Plant Environmental Management has established Standard Operating Procedures (SOPs) for the performance of a wide variety of RFI/RI related tasks. To ensure quality and uniformity in the execution of the OU 8 Work Plan, the Work Plan specifies SOPs that are to be employed for each sampling task. Each IHSS may have unique conditions that require modification of an SOP; modifications will be requested by a Document Change Notice (DCN). Those activities that generate appreciable quantities of particulates will be conducted in accordance with the Rocky Flats Plan for Prevention of Contaminant Dispersion (PPCD).

6.4 SAMPLING METHODS, LOCATIONS, AND FREQUENCY

The primary goal of the OU8 Phase I FSAP is to collect the data necessary to fulfill the Phase I Work Plan objectives outlined in Section 1.0.

The FSAP is derived primarily from Table 5 of the IAG (U.S. DOE, 1991). This document spells out in detail the minimum Phase I sampling and field work requirements for each of the OU8 IHSSs. These requirements were based upon available information about the IHSSs at the time the IAG was drafted. In the course of researching this work plan, additional data have become available (Appendix B), which warrant modifying the scope and/or method of field investigation for a number of OU8 IHSSs. The most recent IHSS descriptions were the sources

used to modify the required actions for each IHSS (Doty & Associates, "IAG Required Action Comments"). The field work proposed in this FSAP for a particular IHSS may therefore vary from that stipulated in the IAG. Tables 6.1 and 6.2 summarize the IAG Phase I field work requirements for each OU8 IHSS, as well as any proposed modifications to these requirements.

It is recognized that the FSAP must remain flexible in order to accommodate RFP operations and security requirements, utilities, interferences, and similar variables. Subsequent stages of the plan must also allow for adjustment to the data obtained in earlier stages; for instance, final borehole locations cannot reasonably be selected before the results of field detection instrument surveys are interpreted.

All FSAP work will be conducted based on the DQOs and EG&G Rocky Flats Plant Standard Operating Procedures (SOPs). These documents will provide specifications for sample collection, handling and analytical protocol. The SOPs and Health and Safety (H&S) guidance documents will be of particular importance in implementing the Phase I RFI/RI activities.

6.4.1 Stage I - Underdrains

It is anticipated that groundwater is being collected in underdrain systems located around the perimeter of foundation footings of some buildings. An analysis of this situation will require additional information regarding the existence of perimeter footing underdrains. It is unknown if each building actually has a perimeter footing underdrain system in place. The available plant plans will be reviewed for design and construction information.

Another entry point for groundwater contaminants into the sanitary and storm sewer systems is via infiltration through joints, cracks, and other types of breaks in the closed conduit (ASI, 1990 and 1991). The infiltration and exfiltration of the storm and sanitary sewer systems was analyzed using mass-balance techniques by ASI. This information will be reviewed to determine which segments of pipe are likely to have additional water entering from the groundwater table.

6.4.2 Stage II - Media Sampling and Investigations

6.4.2.1 Stage IIA - Surficial Soils

Primary FSAP sub-stages for sampling surficial materials have been identified. These sub-stages, are described in detail in the following sections:

- Sub-Stage 1 -- Facility Coordination and Mobilization
- Sub-Stage 2 -- Field Surveys
  - Sub-Stage 2a -- Portable GC Soil-Gas Surveys
  - Sub-Stage 2b -- Radiation Screening Surveys
- Sub-Stage 3 -- Surface Investigations
  - Sub-Stage 3a -- Surface Scrapings
  - Sub-Stage 3b -- Shallow Soil Samples
  - Sub-Stage 3c -- Evaluation of Surface Water and Sediments Data
  - Sub-Stage 3d -- Technical Memorandum 1
- Sub-Stage 4 -- Subsurface Investigations
  - Sub-Stage 4a -- Soil Borings
  - Sub-Stage 4b -- Matric Potential
  - Sub-Stage 4c -- Technical Memorandum 2
- Sub-Stage 5 -- BAT (Vadose Water) Sampling (contingent on 4b)
  - Sub-Stage 5a -- Technical Memorandum 3
- Sub-Stage 6 -- Additional Soil Borings (contingent on above investigations)

Table 6.2 provides the specific number and type of samples to be collected at each IHSS. Without further evaluation of the RFEDS data, the sampling grid spacing used to determine the number and location of sampling points are those specified in the IAG. Figure 6-1 provides a sequential flow chart for which these tasks will be performed.

Sub-Stage-1 -- Facility Coordination and Mobilization

Sub-Stage 1 will address the logistics of FSAP implementation prior to the commencement of field work. Detailed coordination with several RFP departments will be necessary. A Health and Safety Plan will be prepared with input from RFP health and safety personnel and from the EG&G Radiological Engineering Group. Because most of the OU8 IHSSs are within sensitive areas, coordination with RFP security will be of particular importance. Facility operations personnel will be apprised of planned activities and schedules such that interference with RFP operations in minimized. Drilling permits, RFP excavations permits, and other required permits will be obtained. Qualified drilling and excavation subcontractors will be secured.

Sub-Stage 2 -- Field Surveys

Site investigative work will commence with field detection instrument surveys specified by the IAG for a number of OU8 IHSSs. These include Portable Gas Chromatography (GC) soil-gas surveys and radiation screening surveys.

Tanks, valve vaults, and underground pipes constitute the primary contamination source in numerous OU8 IHSSs. The physical condition of these structures, as well as the presence of residual product or waste materials, will bear upon site characterization and selection of remedial alternatives. Sub-Stage 2 will also include inspection (and sampling, where appropriate) of tanks, drain systems, and pipelines associated with OU8 IHSSs.

Sub-Stage 2a -- Portable GC Soil Gas Surveys

Soil gas surveys, utilizing portable GC units, will be conducted at IHSSs with suspected organic compound contamination. The survey is designed to detect and quantify organic vapors in unsaturated (vadose zone) soils, and is most effective for volatile organic contaminants. Certain semi-volatile compounds with higher vapor pressures may also be detectable. In accordance with

the IAG, samples collected from IHSS Nos. 146.1 - 146.6 will be analyzed for TCL semi-volatiles. The purpose of the soil gas surveys is merely to determine if contamination is present.

Soil-gas samples will be collected by driving a small diameter stainless steel sampling probe approximately five feet below ground surface. A vacuum will be applied to the sampling probe to induce air flow from the soil pore spaces (soil gas) into the sampling probe. A sufficient volume of soil gas will be purged through the sample probe to ensure that a representative sample will be obtained. A sample of the soil gas will then be collected, using a gas-tight syringe inserted through fittings at the top of the sample probe.

Once the soil-gas sample has been collected, the sample will be analyzed using a portable field GC. The GC will be calibrated for the compounds of interest, and the results will generally be available the same day the sample is collected. This methodology allows for modifications to the sampling program to be made as the sample results are obtained. All sampling protocol will be in accordance with SOP GT.09, Soil Gas Sampling and Field Analysis and SOP.GT.19 Field Gas Chromatographies.

Sub-Stage 2b -- Radiation Screening Surveys

Radiation surveys will be conducted over the ground surface at selected IHSSs with suspected radioactive contamination. The surveys are intended to help delineate the extent of near-surface radioactive contamination possibly related to releases from the IHSSs. They will be conducted with suitable instrumentation, in accordance with SOP FO.16 Field Radiological Measurements, and will employ field techniques established by RFP radiation monitoring personnel. It is suggested that for gamma detection the FIDLER be used at sites with boundaries smaller than the high purity germanium's (HPGs) diameter of detection of the and the HPG be used at all sites with boundaries equal to or larger than the of the HPG diameter of detection.

Most of the IHSSs to be surveyed are adjacent to buildings within production areas of the RFP. Many of these buildings contain materials which elevate local background radiation, making it difficult to interpret small fluctuations in nearby radiation readings (EG&G, 1990e). It is likely, therefore, that the surveys will at best establish areas of gross contamination which could potentially impact field personnel health and safety practices. The results will provide a qualitative indication of near-surface radioactive contamination, and will help to focus the soil sampling efforts of subsequent tasks. The survey may also prove helpful in prescribing worker protection for sampling operations. As stipulated in the IAG, survey grids will be tightened if anomalous "hotspots" (areas in which radioactivity is detected above background as determined in EG&G's Background Geochemical Characterization Report, 1990b) are detected. Where pavement precludes radiation screening of potentially affected soils, surface soil samples will be collected from beneath the pavement and screened in the laboratory. Areas of concern will be given an identification number, logged, and marked.

A walkover radiation screening survey of RFP was conducted between 1975 - 1983 (Yoder, R.E., 1984). Radioactively-contaminated soil detected through this survey apparently was removed from several areas (EG&G, 1990c). Aerial radiometric surveys of RFP have also been conducted periodically by EG&G Energy Measurements Group. These large-scale surveys focused on areas surrounding RFP as well as RFP itself, and provide limited data on radiation levels within the OU8 area. Results from the aerial surveys form a basis for IAG sampling requirements for several OU8 IHSSs.

Sub-Stage 3 Surface Investigations

Sub-Stage 3a -- Surface Samples

Surface soil samples (and pavement samples where applicable) will be collected for laboratory analysis from numerous OU8 IHSSs. The IAG establishes sampling grids across most of the IHSSs targeted for surface sampling, and also specifies the depth of collection and analytical

parameters (Tables 6.1 and 6.2). Prospective sampling locations are shown on Figures 6-2 and 6-3. At many IHSSs, surface soil is to be sampled at soil boring locations and analyzed for the same parameters as boring samples. These surface samples will be collected immediately prior to drilling at each boring location. Sub-Stage 3a addresses surface samples from those IHSSs at which no soil borings will be drilled.

Sub-Stage 3a will be performed in accordance with SOP GT.08, Surface Soil Sampling. At sampling sites that have been paved subsequent to the incident responsible for contaminating the area, individual grab samples will be collected from the soil beneath the pavement. Typical RFI/RI surface and shallow soil sampling SOPs call for samples to be collected by trained personnel with a suitable instrument (e.g., a precleaned stainless steel trowel) and placed in an appropriately-labeled sampler container. The sample is described as completely as possible by field personnel. Sampling instruments are completely cleaned and decontaminated between samples. Sample preservation is achieved by cooling with ice. Transfer of the samples to a certified laboratory is accomplished within the maximum time allowable for the applicable analyses. Detailed documentation of sample collection and chain-of-custody will be completed for each sample. The samples will be screened for gross radioactive contamination by EG&G radiation monitoring personnel prior to shipment to the analytical laboratory.

Sub-Stage 3b -- Shallow Soil Samples

Shallow soil samples will be collected for laboratory analysis from numerous OU8 IHSSs. Shallow soil samples are defined herein as those collected from a depth of less than six feet, or those able to be collected by hand auger. The IAG establishes sampling grids across most of the IHSSs targeted for shallow soil sampling, and also specifies the depth of collection and analytical parameters (Tables 6.1 and 6.2). Prospective sampling locations are shown on Figures 6-2 and 6-3.

Sub-Stage 3b will be performed in accordance with the EG&G SOPs presented in the discussion of Sub-Stage 4. Typical RFI/RI shallow soil sampling SOPs call for samples to be collected by trained personnel with a suitable instrument (e.g. a precleaned stainless steel hand auger and thin-walled sampler for shallow soil) and placed in an appropriately labeled sampler container. The sample is described as completely as possible by field personnel. Sampling instruments are completely cleaned and decontaminated between samples. Sample preservation is achieved by cooling with ice. Transfer of the samples to a certified laboratory is accomplished within the maximum time allowable for the applicable analyses. Detailed documentation of sample collection and chain-of-custody will be completed for each sample. The samples will be screened for gross radioactive contamination by EG&G radiation monitoring personnel prior to shipment to the analytical laboratory.

Sub-Stage 3c -- Evaluation of Surface Water and Sediments Data

Following the completion of surface sampling and shallow soil sampling, the results of the surface water and sediment sampling program will be compiled and evaluated. This information will supplement the results of the surface and shallow soil sampling program and allow for a better evaluation of the nature and extent of contamination in addition to providing guidance to the following stages of work.

Sub-Stage 3d -- Technical Memorandum 1

A technical memorandum will be issued to the leading agency(ies) detailing the results from the work completed for sub-stages 1 through 3c. In addition, recommendations will be made with respect to how the following sub-stages will be completed for the Phase I investigation.

Sub-Stage 4 -- Subsurface Investigations

Sub-Stage 4a -- Soil Borings

Continuously-sampled borings are to be drilled at selected OU8 IHSSs. The primary objective of these borings is to collect soil samples for laboratory analysis to determine the nature and extent of contamination. Geologic and hydrologic data at each location, such as depth and nature of subcropping bedrock and depth to water table, will also be obtained. The borings will be drilled down to the water table or 6 feet into the bedrock, which ever is shallower, unless otherwise specified by the IAG. Table 6.1 provides IAG boring depth specifications. In most cases, surface soil scrapings will be collected at each boring location. Prospective boring locations are shown in Figures 6.2 and 6.3. Where portable GC soil-gas surveys are required, final boring locations will be based upon survey results. Locations will be marked and surveyed prior to drilling. Soil borings will be completed in accordance to the following SOPs:

- SOP GT.17 Land Surveying
- SOP GT.10 Borehole Clearing
- SOP FO.03 General Equipment Decontamination
- SOP FO.04 Heavy Equipment Decontamination
- SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques
- SOP GT.01 Logging Alluvial and Bedrock Material
- SOP FO.08 Handling Drilling Fluids and Cuttings
- SOP GT.05 Plugging and Abandonment of Boreholes
- SOP FO.09 Handling of Residual Soil Samples
- SOP FO.18 Environmental Sample Radioactive Content Screening

Typical RFI/RI borehole soil sampling SOPs are similar to those for surface and shallow soil samples outlined in the previous section. Field personnel are also required to fully document the drilling operation and to record detailed geologic and hydrologic information as the hole progresses. Hollow stem auger drilling is the typical method used for soil borings at RFP. The

SOPs probably will specify continuously-sampled borings, in which a thin-walled sampler attached in advance of the auger cutting head allows undisturbed samples to be taken continuously as drilling progresses. Continuously-sampled borings require detailed physical descriptions of the materials sampled. Samples for analysis are taken from the continuously-sampled material. The intervals from which these are removed are carefully marked and documented. Remaining samples are placed into appropriately-labeled containers (typically core boxes) and are logged into a designated storage facility.

Personnel health and safety procedures for drill rig work will be set forth in the project-specific Health and Safety Plan, as well as in the EG&G guidance documents. These documents will address worker health and safety training requirements, personal protective clothing, personnel and equipment decontamination, health and safety monitoring, the establishment of site control zones around the drilling area, emergency procedures, and related health and safety issues.

Sub-Stage 4b -- Matric Potential

Soil matric potential can be obtained using a variety of methods. However, the semi-arid soils of RFP will most likely have potentials below instrument capabilities. If the matric potential of the soils is less than approximately 1.0 bars, then methods such as time domain reflectometry, oven drying, or the equivalent, can be used to determine soil moisture, which in conjunction with standard software applications would then be used to estimate matric potential. Also, soil moisture can be obtained from the core samples as they are extracted from the ground during the soil boring program.

Sub-Stage 4c -- Technical Memorandum 2

A technical memorandum will be issued to the leading agency(ies) detailing the results of the work performed in sub-stages 4a and 4b and recapping the information provided in the Technical

Memorandum 1. In addition, recommendations will be made with respect to how to proceed with the remaining sub-stages for the Phase I investigation.

Sub-Stage 5 -- BAT (Vadose Water) Sampling

Vadose zone water samples will be collected for laboratory analysis from numerous OU8 IHSSs provided the soil moisture is great enough (1.0 bars) to allow for sample collection. Vadose zone water is defined herein as the water contained within the soils from between the ground surface down to the water table. These samples will be collected in areas that are determined via soil boring sampling to contain contaminants. A BAT sampler will be used to collect these samples and analyzed for the same parameters as the soil samples are analyzed for. These surface samples will be collected following the results of the soil boring program.

BAT samples will be collected by trained personnel with suitable instrumentation and placed in an appropriately-labeled sampler container. The sample collection technique and surrounding circumstances will be described as completely as possible by field personnel. Sampling instruments will be completely cleaned and decontaminated between samples. A mobile lab with GC or GC/MS instrumentation will be on site to provide real time results for organic analytes. For those constituents that a GC or GC/MS cannot detect, sample preservation will be achieved by cooling with ice. Transfer of the samples to a certified laboratory will be accomplished within the maximum time allowable for the applicable analyses. Detailed documentation of sample collection and chain-of-custody will be completed for each sample. The samples will be screened for gross radioactive contamination by EG&G radiation monitoring personnel prior to shipment to the analytical laboratory.

Sub-Stage 5a -- Technical Memorandum 3

A technical memorandum will be issued to the leading agency(ies) detailing the results of the work performed in all subsequent sub-stages and recapping the information provided in previous

Technical Memorandums. In addition, recommendations will be made with respect to how to proceed with the remaining sub-stages for the Phase I investigation.

Sub-Stage 6 -- Additional Soil Borings

Additional soil borings may be required to fully assess the nature and extent of contamination at some of the OU8 IHSSs. Following the work performed for sub-stages 1 through 5, it may be evident that further investigation is necessary. Figure 6-1 shows a logical sequence of events that could lead to additional soil borings. In the event that additional soil borings are needed, the drilling and sample collection methods and techniques will be the same as outlined in sub-stage 4.

6.4.2.2 Stage IIB - Surface Water and Sediments

One of the objectives of the surface-water and sediment sampling plan is to define contamination boundaries and determine the likelihood of further contamination migration via open drainageways and closed-conduit piping systems. This can be done by a multi-staged approach as outlined below where each subsequent sub-stage is dependent on the results obtained from the previous sub-stage.

Sub-Stage 1 - Open Drainageway Sampling Activities

Surface water and sediment will be sampled upgradient from the existing sampling sites at locations chosen to isolate individual or groups of IHSSs within drainage sub-basins. Surface-water sampling points should be located at outfalls of storm sewer systems and underdrain trunk lines, upstream of confluence points between two open drainageways, and within open drainageways, where applicable. The sediment samples will be collected in areas of the drainageways that are exhibiting signs of channel-bottom aggradation, such as wide, flat areas, or immediately upstream of control structures.

Sub-Stage 2 - Evaluate Drainageway Data

As data from Sub-Stage 1 becomes available, this information will be processed and analyzed in an effort to identify expected contaminants from known IHSSs located upstream and to determine the source and areal extent of each contaminant. Based on the results of this data interpretation, a decision will be made regarding the need for and location of additional sampling sites.

Sub-Stage 3 - Additional Sampling Activities in Drainageways

The steps taken in sub-stages 1 and 2 will be repeated until the required information is obtained. When the additional sampling required is within the storm sewer system, sub-stage 4 applies.

Sub-Stage 4 - Locate Underdrain Connections and Additional Sampling Locations

It is anticipated that additional surface-water and sediment sampling will be required within the storm sewer and/or sanitary sewer systems in order to reliably isolate a given IHSS as the source of contaminants. This will require knowledge of the existence of perimeter footing underdrains and the location of the connection into sanitary or storm sewer systems or daylight points into drainageways.

It is currently unknown which buildings actually have a perimeter footing underdrain system in place. This will be determined as indicated in Section 6.4.1. If a system is in place, the location of the connection to an existing sanitary or storm sewer system will be determined. Plant plans will be reviewed and a video camera inspection of the pipe interior will be conducted to identify the location of connections which occur at points other than accessible manholes.

A copy of the plant utility plans showing the horizonal location of storm/sanitary sewer systems will then be updated using the information obtained in sub-stage 3 to show the location of each

accessible manhole and the location of each known underdrain connection. This plan will be used to determine locations for additional surface-water and sediment sampling.

Sub-stage 5 - Evaluate Data Collected During Stage 4.

As data from Sub-Stage 5 becomes available, this information will be processed and analyzed in an effort to identify expected contaminants from known IHSSs located upstream and to determine the source and areal extent of each contaminant. Based on the results of this data interpretation, a decision will be made regarding the need for and location of additional sampling sites.

Sub-Stage 6 - Additional Sampling Activities Within Closed Conduit Systems

The steps taken in sub-stages 5 and 6 will be repeated until the required information is obtained.

6.4.2.3 Stage IIC - Groundwater

Preliminary FSAP substages for groundwater sampling are identified below. With the exception of the installation of monitoring wells near IHSSs 125 and 126, these stages, to be performed sequentially, are described in detail in the following sections:

- Sub-Stage 1 Groundwater Sampling of the Saturated Zone
- Sub-Stage 2
  - A. Review of Soil and Groundwater Data
  - B. Evaluation of Footings Drains Effects on Flow Field
  - C. Installation of IAG-Mandated Groundwater Monitoring Wells
- Sub-Stage 3 Installation of Piezometers Near Footings Drains
- Sub-Stage 4 Review of Data from Piezometers Near Footings Drains
- Sub-Stage 5 Installation of Groundwater Monitoring Wells

Table 6.2 provides a list of the IHSSs to be sampled for groundwater.

The following stages will be implemented in a fashion consistent with Stage 1, Facility Coordination and Mobilization as set forth in Section 6.4.1, Surficial Materials.

Sub-Stage 1 -- Groundwater of the Saturated Zone

Substage 1 will address the investigation of the saturated zone using a BAT or similar sampling technique. All boreholes initiated under Sub-stage 4a of the Surficial Materials sampling plan (Section 6.4.1) will be sampled for groundwater at the top of the uppermost hydrostratigraphic unit and at the base of the uppermost hydrostratigraphic unit, thereby allowing for detection of both dense, nonaqueous-phase liquids (DNAPLs), light, nonaqueous-phase liquids (LNAPLs), and soluble compounds. If the first three feet of bedrock is claystone, silty claystone, or other relatively impermeable material, then the base of the uppermost hydrostratigraphic unit will be considered the base of the surficial materials. If within the first three feet of bedrock a sandstone is encountered, then the hole must be augered through the entire thickness of the sandstone unit, three feet into a claystone, silty claystone or other relatively impermeable unit. In this case, the base of the uppermost hydrostratigraphic unit will be considered to be the base of the sandstone unit. BAT or similar samples will be collected and preserved as stated in Section 6.4.1, Sub-stage 5 -- Vadose Water Sampling.

Sub-Stage 2A -- Review of Soil and Groundwater Data

Data collected during the previous stages of the FSAP, particularly soil gas survey, soil scrapings, soil borings, vadose zone groundwater samples and saturated zone groundwater samples will be reviewed to assess the presence of contaminant and the level of contaminant impact on the groundwater system.

Sub-Stage 2B -- Evaluation of Footings Drains Effects on Flow Field

Locations and elevations of the footings drains obtained in Stage 1B above will be evaluated in context of historic high water levels to determine whether the drains create an impact on the water table flow field.

Sub-Stage 2C -- Installation of IAG-Mandated Groundwater Monitoring Wells

Groundwater monitoring wells will be installed near IHSSs 125 and 126. Two downgradient wells will be installed north of IHSS 125 as is shown on Figure 6-2. One downgradient monitoring well will be installed northwest of 126.1 and 126.2 also as shown on Figure xxx. These wells will be installed as set forth in SOP GT.06, Monitor Well and Piezometer Installation (EG&G, 1991).

Sub-Stage 3 -- Installation of Piezometers Near Footings Drains

Based on the results obtained in Substage 2B, piezometers will be installed at strategic locations near footings drains which are judged to have an effect on the groundwater flow regime. These piezometers will be installed according to pertinent operating procedures set forth in SOP GT.06, Monitor Well and Piezometer Installation (EG&G, 1991). Groundwater samples will be collected during installation using a BAT or similar sampler at the top and at the base of the uppermost hydrostratigraphic unit.

Sub-Stage 4 -- Review of Data from Piezometers Near Footings Drains

Water level and groundwater sample data collected from the footings drains piezometers will be analyzed to evaluate the effect of the drains on the groundwater flow regime, the presence of contaminants, the possible source of diverted contaminants and the possible fate of diverted contaminants.

Sub-Stage 5 -- Installation of Groundwater Monitoring Wells

Based on the results of Substages 2a and 4 above, monitoring wells will be installed for the purpose of collecting groundwater samples and measuring water levels. The monitoring wells will be installed as set forth in SOP GT.06, Monitor Well and Piezometer Installation (EG&G, 1991).

6.4.2.4 Stage IID - Air Sampling Program

6.4.2.4.1 Existing Resources

Characterization of ambient air quality at OU8 will require compilation of relevant existing data and collection of additional data to fill informational gaps. The relevant meteorological data collected from the RFP monitoring station include wind speed, wind direction, sigma theta, temperature, relative humidity, and precipitation. Hourly averages of these data are required for performance of air quality impact analysis. The wind data should be used to generate daily wind roses. Daily summaries of the other parameters will be required. A continual review of existing data that pertains to assessment of OU8 air quality should be conducted as part of the Workplan. These reviews should include comparison of ambient air contaminant concentrations derived from previous modeling or monitoring programs.

Data use objectives require ambient air concentrations and distributions of the individual contaminants on and off the site. The existing ambient air monitoring program offers the spatial resolution necessary to meet these objectives for airborne plutonium and particulate material emitted from RFP as a whole. The existing monitoring stations located near individual IHSS sites will typically offer only limited support in definition of OU-8 IHSS site air pathways. This IHSS site-specific support can be maximized by coordinating individual monitor operation schedules and correlating the collected data to IHSS site field activities and existing site

conditions. Isopleth maps can then be developed as necessary to establish maximum and mean exposure levels on the site and quantify the off-site transport of contaminants.

Monitoring station locations should be selected on the basis of the dominant wind patterns at the site. Since the plumes from IHSS sites will be directed by the wind, locating monitors downwind will allow sampling of the plumes. The primary wind direction is northwesterly. Additional stations should be positioned to monitor concentrations when the winds are not from the primary direction.

There are six ambient air monitoring stations of interest to this investigation. These six samplers encircle the OU and should provide representative airborne particulate samples both upwind and downwind (according to prevailing area wind patterns). The specific ambient air monitoring sites suitable for data review when defining OU8 IHSS site air pathways include S-1, S-3, S-5, S-17, S-20, and S-21. With respect to prevailing wind patterns at RFP, S-3 and S-21 (or alternatively, S-4 and S-16) would generally represent upwind conditions while S-1, S-5, S-17, and S-20 represent downwind conditions relative to OU-8. Additional monitoring stations that might contribute to downwind IHSS site-specific air pathway definition include S-2, S-6, S-8B, and S-19. It should be noted that S-5 and S-6 have historically provided the highest area plutonium concentrations (Section 5.1, Table 5.1-6). It must also be remembered that all monitoring site measurements represent multiple RFP sources and may provide upwardly-biased information with regard to a specific OU8 IHSS site. Similarly, IHSS sites located closely to an operational downwind monitor would provide more reliable data than one situated a long distance upwind.

6.4.2.4.2 Additional Data Collection

Localized air monitoring will be performed during field activities to ensure that quality data are obtained during sampling. All sampling activities will be performed in compliance with the RFP PPCD and in accordance with OP FO.1, Air Monitoring and Dust Control.

Area air quality monitoring requirements will be implemented whenever activities such as borehole drilling are performed and significant potential for production of appreciable quantities of airborne particulates or release of volatile organic materials is possible. These requirements include:

- Continued operation and monitoring of the Site Perimeter and Community Radiological Ambient Air Monitoring Program (RAAMP). Six of these samplers (S-1, S-3, S-5, S-17, S-20, S-21) are located within or immediately adjacent to OU-8 and will be relied upon to characterize the local area air pathway.

- Local monitoring of Respirable Suspended Particulates (RSP) at individual activity work sites using real-time respirable aerosol mass monitors. Local RSP measurements will be employed to guide the project manager's evaluation of the potential hazards associated with work activity-related emissions. The threshold RSP concentration for curtailing intrusive activities will be 6.0 mg/m^3.

- Additional worker health and safety monitoring as required by the Site-Specific Health and Safety Plan (SSH&SP). This includes initial area radiation surveys intended to identify possible radiation hazards that could be associated with airborne particulates.

Soil-gas surveys are planned for select IHSS sites believed containing VOCs. This data can: (1) Identify areas of higher than average soil-gas contaminant content and their movements, (2) Serve as model inputs (source terms) to estimate ambient air concentration under changing meteorological conditions, and (3) Estimate uncontrolled emissions levels during invasive site operations. These VOCs would have the potential to be released to the atmosphere during actual sample acquision or as an emission from completed instrumentation (i.e., well headspace). This information can be coupled with indirect portable ambient air monitoring data collected in accordance with the Site-Specific Health and Safety Plan to help understand the potential imacts attributable to individual IHSS sites.

6.5 SAMPLE COLLECTION AND ANALYSIS

The purpose of this section is to develop field sample collection and analysis methods. These methods would then be applied to the sampling requirements presented in Section 11.4 by providing procedures for sampling tasks and identifying analytical levels and methodologies.

6.5.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the RFEDS. Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "AS" for Advanced Sciences). One sample number will be required for each sample generated, including QA/QC samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the data base. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU8. Boring numbers will be developed independently of the sample numbers for a boring.

6.5.2 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance describing container labeling, decontamination, field packaging, chain of custody records, field data documentation, packaging, and shipping is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples (EG&G, 1992c).

The field data and reporting requirements are discussed in detail in the SOP FO.14 Field Data Management (EG&G, 1992c). In general the following procedures must be followed:

- Collection of data on pre-printed forms;
- Preliminary verification of the data;
- Technical verification by a qualified verifier;
- Data input into the RFEDS;
- Verification of input;
- Archiving and filing of data;
- Security of database and computers;
- Documentation of implementation of the referenced SOP; and
- Use of data management forms.

6.5.3 Sample Containers and Preservation

The type of analysis and media to be sampled dictates the sample container volume and material requirements, preservation techniques, and holding times. The parameters specific to OU8 with the corresponding containers, preservative, and holding time are listed in Table 6.3. Additional specific information relating to sample containers and preservatives is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples (EG&G, 1992c).

6.5.4 Field QA/QC Procedures

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the EMD project manager to assess the quality of the field sampling effort. The

types of field QC samples to be collected and their application are discussed below. The frequency with which QC samples will be collected and analyzed is provided in Table 6.4.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and placed in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field blanks of distilled water will be prepared by the sampling team and will be used to provide any indication of any contamination introduced during field preparation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on non-dedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample containers.

Trip blanks consisting of distilled water will be prepared by the laboratory technician and will accompany each shipment of samples for VOC analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of VOCs or any problems associated with sample shipment, handling, or storage. Information from the trip blanks will be used in conjunction with air monitoring data and other information to assess the influence of ongoing waste operations on the quality of data collected.

6.5.5 Prevention of Contaminant Dispersion

Contaminants may be dispersed as a result of soil disturbance and airborne/surface water transport, smearing of the soil profile, venting of volatile compounds from the subsurface, and cross connection of water-bearing zones.

The procedures for borehole soil sampling are outlined in:

- SOP GT.17 Land Surveying,
- SOP GT.10 Borehole Clearing,
- SOP FO.03 General Equipment Decontamination,
- SOP FO.04 Heavy Equipment Decontamination,
- SOP GT.02 Drilling and Sampling Using Hollow Stem Auger Techniques,
- SOP GT.01 Logging Alluvial and Bedrock Material,
- SOP FO.08 Handling Drilling Fluids and Cuttings,
- SOP GT.05 Plugging and Abandonment of Boreholes,
- SOP FO.09 Handling of Residual Soil Samples, and
- SOP FO.18 Environmental Sample Radioactive Content Screening (EG&G 1992c, EG&G, 1992d).

These methods reduce the likelihood of contaminant dispersion.

Localized air monitoring will be performed during field activities to ensure that quality data are obtained during sampling. All sampling activities will be performed in compliance with the RFP PPCD and in accordance with SOP FO.1, Air Monitoring and Dust Control (EG&G, 1992c).

In the case that contamination is being dispersed through air pathways in significant amounts as determined by monitoring outlined in Section 6, activities will be stopped until appropriate measures can be applied.

Soil-gas surveys will be performed as identified in Section 6.4. Soil gas data will be collected for select OU8 IHSS sites that appear to be potentially contaminated with volatile organic contaminants. These VOCs do have the potential to be released to the atmosphere during actual sample acquisition or as an emission from completed instrumentation (i.e., well headspace). Worker health and safety monitoring will be performed for these potential hazards as required by the Site-Specific Health and Safety Plan.

The procedures for installation of groundwater monitoring wells are previously outlined under borehole soil sampling procedures (EG&G 1992c; EG&G 1992d).

6.5.6 Analytical Requirements

As discussed in Section 6.4, analytical parameters are based on the rationale that the operational history and release history are not clearly defined. In general, initial soil and groundwater samples will be analyzed for the following chemical and radionuclide parameters:

- Target Analyte List (TAL) Metals,
- Total Organic Carbon (TOC),
- Target Compound List (TCL) Volatiles,
- Target Compound List (TCL) Semivolatiles,
- Radionuclides,
- Anions,
- pH, and
- Specific conductance.

Field measurement of temperature, Ph, and specific conductance will be taken on groundwater samples obtained in accordance with SOP GW.05 Field Measurement of Groundwater Field Parameters and SOP GW.06 Groundwater Sampling (EG&G 1991a).

The OU8 analytical parameter list may be modified for some IHSSs based on the results of additional data compilation activities in Section 6.4. Later stage analytical parameters will focus on only those contaminants identified in the earlier stages. Decisions regarding analytical parameter selection will be documented by submitting Technical Memoranda.

6.6 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND ADDENDUM

All work conducted in support of OU8 Phase I RFI/RI activities will be directed by the EG&G Environmental Management Department Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facilities Investigation/Corrective Measures Study Activities (QAPjP). The QAPjP complies with the requirements of EPA QAMS-005/80 and DOE Order 5700.6B which addresses NQA-1.

The QAPjP will be supplemented by a Quality Assurance Addendum (QAA) specific to OU8. The QAA will be provided to ASI by EG&G for inclusion in the Work Plan after EG&G completes review of the Draft Work Plan. The QAA will establish the specific Quality Assurance controls applicable to the field investigation activities described in the OU8 Work Plan.

TABLE 6.1

OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
118.1	GC soil gas survey on 10 foot grid: analyze for carbon tetrachloride, 1,1,1-TCA, benzene, methyethyl ketone, dichloromethane, PCE, and TCE.	NA	Four borings along longitudinal transect of site 118.1. One random boring located at the same location as a GC soil gas survey location. Surface scraping from location of each boring. Discrete samples taken at 4 foot intervals for TCL volatiles. Soil surface scrapes will be analyzed for total plutonium, americium, tritium, total uranium, gross alpha and gross beta.	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Use 10 foot grid for soil gas survey due to size of tank. Soil gas detection limits will depend upon instrument used. Analytes include americium. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
118.2	GC soil gas survey on 10 foot grid: analyze for carbon tetrachloride, 1,1,1-TCA, benzene, methyethyl ketone, dichloromethane, PCE, and TCE.	NA	Two borings along longitudinal transect of site 118.2. One random boring located at the same location as one of the GC soil gas survey locations. Discrete samples taken at 4 foot intervals and analyzed for TCL volatiles. Soil surface scraping taken from location of each boring. Soil surface scrapes will be analyzed for total plutonium, americium, tritium, total uranium, gross alpha and gross beta.	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Use 10 foot grid for soil gas survey due to size of tank. Soil gas detection limits will depend upon instrument used. Analytes include americium. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
123.1 123.2	NA	NA	Drill borings at locations affected by sites 123.1 and 123.2 surrounding each vault (on 30-foot centers) and including surface ditches affected by releases. Borings to be drilled to a depth of 10 feet below the bottom of each vault. Discrete samples shall be taken at 4 foot intervals and analyzed for TCL volatiles. The core samples shall also be composited to represent 6 foot intervals and will be analyzed for total plutonium, americium, beryllium, nitrates, total uranium, gross alpha and gross beta, and fluorides.	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Analytes should include solvents and oils, although specific solvents are not yet known, and americium. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
125	NA	NA	Drill borings at locations affected by site 125. Two borings will be placed around each tank, where feasible, drilled on 10-foot centers on the northeast side of the tanks, to depths of 10 feet below the bottom of each tank. Discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles. The core samples shall also be composited to represent 6 foot intervals. The 6 foot composite core samples will be analyzed for total plutonium, total americium, beryllium, nitrates, total uranium, gross alpha and gross beta. Soil surface scraping from location of each boring will be collected and analyzed for the same constituents as the core samples.	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected. If surface has been paved since releases, sample top two inches of soil and analyze for radiation prior to drilling.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
126.1 126.2	NA	NA	Drill borings at locations downgradient of each tank to depths of 10 feet below the bottom of each tank. Discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles. The core samples shall also be composited to represent 6 foot intervals. The 6 foot composite core samples will be analyzed for total plutonium, total americium, beryllium, nitrates, total uranium, gross alpha and gross beta. Soil surface scraping from location of each boring will be collected and analyzed for the same constituents as the core samples.	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
127	NA	NA	Drill 6 borings at locations within site 127 boundaries at 20 foot centers, and 4 borings on 50-foot centers along pipeline between Bldg. 774 and Tank 207, to 10 feet below pipe invert or six feet into weathered bedrock. Discrete samples shall be taken at 4-foot intervals and analyzed for total plutonium, total nitrate, total uranium, gross alpha and gross beta. Soil surface scraping from location of each boring will be collected and analyzed for total plutonium, americium, total nitrate, total uranium, gross alpha and gross beta, and HSL metals.	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected. If surface has been paved since releases, sample top two inches of soil and analyze for radiation prior to drilling.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Drill 4 additional borings along the pipeline between Bldg. 774 and Tank 207. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
132	NA	NA	Drill borings at locations affected by site 132. Borings will be placed around each tank to depths of 10 feet below the bottom of each tank or 6 feet into weathered bedrock. The core samples shall be composited to represent each 6 foot interval and analyzed for total plutonium, total amerecium, beryllium, total uranium, gross alpha and gross beta.	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
135	NA	Drill borings from locations affected by site 135 at 25 foot centers to depths of 6 feet. Discrete samples shall be taken at 4-foot intervals and analyzed for total chromium, tritium, and phosphate. Soil surface scraping from location of each boring will be collected and analyzed for total chromium, tritium, and phosphate.	NA	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Use 25-foot grid spacing for better characterization. Analytes include tritium and phosphate due to historical use in the cooling tower water. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
137	NA	Drill borings from locations affected by site 137 at 20 foot centers to depths of 6 feet. Discrete samples shall be taken at 4-foot intervals and analyzed for total chromium and phosphate. Soil surface scraping from location of each boring will be collected and analyzed for total chromium and phosphate.	NA	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Anaytes include phosphate due to historical use. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
138	NA	Drill borings from locations affected by site 138 at 25 foot centers to depths of 6 feet. Discrete samples shall be taken at 4-foot intervals and analyzed for total chromium, total plutonium, total americium, total uranium, gross alpha and gross beta, and phosphate. Soil surface scraping from location of each boring will be collected and analyzed for the same constituents as the core samples.	NA	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Analytes include radionuclides and phosphates based on known chemistry of the blowdown water. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
139.1 139.2	NA	Samples on 15 foot centers from top six inches of soils directly surrounding tanks and soils affected by releases from tanks. Samples will be analyzed for sodium, nitrates, potassium and fluoride.	NA	NA	NA	NA	Reduce grid spacing to 15 foot centers since the tanks are small relative to the proposed 25 foot grid pattern. Analytes include nitrates.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
144	NA	NA	Drill borings in all areas affected by site 144 including the hillside 500 feet north. Surface soil scrapings taken at hotspots and prior to borehole placement. Two borcholes shall be located adjacent to the sewer line and shall be drilled to 5 feet below the pipe invert or 6 feet into bedrock. Four boreholes shall be located on the affected hillside. Discrete samples shall be taken at 4-foot intervals and analyzed for total plutonium, total americium, beryllium, total chromium, tritium, total nitrate, uranium 233/234, 235 & 238, gross alpha and gross beta, total sulfate and TAL metals.	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
146.1-146.6	NA	NA	Drill borings on 30-foot spacings at locations in all areas affected by the tank releases, to ten feet below the bottom of the tanks. For 3 of the 6 boreholes, discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles and TCL semi-volatiles. For all six boreholes, the soils shall be composited to represent 6 foot intervals. **Soil surface scraping from location of each boring will be collected. The core samples and surface scrapings will be analyzed for total plutonium, total americium, beryllium, total chromium, tritium, total nitrate, uranium 233/234, 235 & 238, gross alpha and gross beta, total sodium, total sulfate and TAL metals.**	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases from the tanks. Tighten grid if hotspots are detected. **If surface has been paved since releases, sample top two inches of soil and analyze for radiation prior to drilling.**	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
149	NA	NA	Drill borings at locations downgradient of effluent pipe at 50 foot centers, to five feet below pipe invert or six feet into weathered bedrock. Discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles. The core samples shall also be composited to represent 6 foot intervals. Soil surface scraping from location of each boring will be collected. The 6 foot composite core samples and surface scrapings will be analyzed for total plutonium, total americium, beryllium, total chromium, tritium, total nitrate, uranium 233/234, 235 & 238, gross alpha and gross beta, and TAL metals.	Conduct a radiation survey on ten foot grid using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected. If surface has been paved since releases, sample top two inches of soil and analyze for radiation prior to drilling.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
150.1-150.8	NA	NA	Drill borings at locations affected by the 150 sites. Discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles. The samples shall also be composited to represent 6 foot intervals. Soil surface scraping from location of each boring will be collected. The 6 foot composite samples and surface scrapings will be analyzed for total plutonium, total americium, beryllium, total chromium, tritium, total nitrate, uranium 233/234, 235 & 238, gross alpha, gross beta, total sodium, total sulfate, and TAL metals. See Tables 5.2-3 and 6.2 for borehole spacing and frequency.	Conduct a radiation survey on 25 foot grids using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected. If surface has been paved since releases, sample surface and top two inches of soil and analyze for radiation prior to drilling.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
151	GC soil gas survey on 10 foot grid: analyze for benzene, toluene, and xylene.	NA	Four borings around tank, drilled to five feet below bottom of tank or six feet into bedrock, whichever is shallower. Discrete samples shall be taken from every 4-foot interval and analyzed for TCL volatiles.	NA	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
159	NA	NA	Drill borings at locations affected by site 159 at 20 foot centers, to five feet below pipe invert or 6 feet into weathered bedrock. Discrete samples shall be taken at 4-foot intervals and analyzed for TCL volatiles. The core samples shall also be composited to represent 6 foot intervals. Soil surface scraping from location of each boring will be collected. The 6 foot composite core samples and surface scrapings will be analyzed for total plutonium, total americium, beryllium, total chromium, tritium, total nitrate, uranium 233/234, 235 & 238, gross alpha and gross beta, and TAL metals.	Conduct a radiation survey on 10 foot grids using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Scrapes	Radiation Surveys	Matric Potential	BAT Samples	
163.1 163.2	NA	NA	Drill borings at locations affected by site 163. Discrete samples shall be taken at 4-foot intervals. Soil surface scraping from location of each boring will be collected. Surface samples and core samples will be analyzed for total plutonium, total americium, total nitrates, uranium 233/234, 235 & 238, gross alpha and gross beta.	Conduct a radiation survey on 25 foot grids using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas affected by releases. Tighten grid if hotspots are detected. If surface has been paved since releases, sample top two inches of soil and analyze for radiation prior to drilling.	Samples will be collected at two foot intervals at the same locations as soil borings.	BAT samples will be collected at 2 foot intervals where contaminants are detected, provided the matric potential is high enough for sample collection.	Soil borings taken at a depth of 10 feet instead of proposed 4-foot depth. Analytes include nitrates. Determination of matic potential and BAT sampling to characterize the vadose zone.

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Samples	Radiation Surveys	Matric Potential	BAT Samples	
172	NA	Soil and asphalt shall be conducted at locations previously indicated as radioactive and at stopping and unloading points. Soil samples shall be analyzed for TAL metals, carbon tetrachloride, bis(2-ethylhexyl) phthalate, total plutonium, americium, uranium 233/234, 235 & 238, beryllium, gross alpha and gross beta. Ashpalt shall be analyzed for the same constituents as the soil with the exception of carbon tetrachloride, bis(2-ethylhexyl) phthalate.	NA	Conduct a radiation survey on 50 foot grids along Central Avenue and 6th Street roadsides and all other roadsides utilized to transport the wastes, and on 5 foot grids within 50 feet of stopping and unloading points. The survey shall utilize G-M shielded pancake and side-shielded FIDLER detectors. Tighten grid if hotspots are detected.	NA	NA	NA

TABLE 6.1
OPERABLE UNIT NO. 8 FIELD SAMPLING PLAN
(continued)

IHSS NO.	PROPOSED ACTIONS						SUGGESTED MODIFICATIONS TO IAG PLAN
	Soil Gas	Surface/Shallow Soil	Soil Borings/Soil Surface Samples	Radiation Surveys	Matric Potential	BAT Samples	
173	NA	At radiation survey sites indicating radioactive contamination, soil samples, surfacing samples, or surface wipes will be taken to determine the radioactive constituents present. Soils shall be grab sampled. Surfacing samples shall be wipe samples. All samples shall be analyzed for total plutonium, total uranium, total americium, total cesium, total strontium, beryllium, tritium, gross alpha and gross beta.	NA	Conduct a radiation survey on 25 foot grids using G-M shielded pancake and side-shielded FIDLER detectors. Cover all areas external to Bldg 991.	NA	NA	NA
184	NA	NA	NA	NA	NA	NA	NA
188	NA	NA	NA	NA	NA	NA	NA

TABLE 6.2

SURFICIAL MATERIAL SAMPLING METHODS & FREQUENCIES

IHSS Identification	Real Time Soil Gas Survey	Soil Borings	Soil Surface Scrapes	Radiation Survey	Shallow Soil Samples	Matric Potential Samples	BAT Samples	Groundwater Samples
118.1	16	5	5	NA	NA	5	TBD*	10
118.2	16	3	3	NA	NA	3	TBD*	6
123.1 & 123.2	NA	8 (4/SITE)	NA	1	NA	8 (4/SITE)	TBD*	16
125	NA	2	2	1	NA	2	TBD*	TBD*
126.1 & 126.2	NA	2 (1/SITE)	2 (1/SITE)	NA	NA	2 (1/SITE)	TBD*	4
127	NA	10	10	1	NA	10	TBD*	18
132	NA	TBD*	NA	NA	NA	TBD*	TBD*	26
135	NA	NA	30	NA	30	30	TBD*	NA
137	NA	NA	10	NA	10	10	TBD*	NA
138	NA	NA	9	NA	9	9	TBD*	NA
139.1(N)&(S)	NA	NA	NA	NA	20	NA	NA	NA
139.2	NA	NA	NA	NA	20	NA	NA	NA
144	NA	6	TBD*	1	NA	6	TBD*	12
146.1-146.6	NA	6	6	1	NA	6	TBD*	12
149	NA	11	11	1	NA	11	TBD*	22
150.1	NA	10	10	1	NA	10	TBD*	20
150.2	NA	20	20	1	NA	20	TBD*	40
150.3	NA	6	6	1	NA	6	TBD*	12
150.4	NA	8	8	1	NA	8	TBD*	16

TABLE 6.2

SURFICIAL MATERIAL SAMPLING METHODS & FREQUENCIES
(continued)

IHSS Identification	Real Time Soil Gas Survey	Soil Borings	Soil Surface Scrapes	Radiation Survey	Shallow Soil Samples	Matric Potential Samples	BAT Samples	Groundwater Samples
150.5	NA	10	10	1	NA	10	TBD*	20
150.6	NA	8	8	1	NA	8	TBD*	16
150.7	NA	10	10	1	NA	10	TBD*	20
150.8	NA	3	3	1	NA	3	TBD*	6
151	42	4	NA	NA	NA	4	TBD*	8
159	NA	7	7	1	NA	7	TBD*	14
163.1 & 163.2	NA	TBD*	TBD*	1	NA	TBD*	TBD*	TBD*
172	NA	NA	NA	1	TBD*	NA	NA	NA
173	NA	NA	NA	1	TBD*	NA	NA	NA
184	NA	NA	NA	NA	NA	NA	NA	NA
188	NA	NA	NA	NA	NA	NA	NA	NA

TBD* - To be determined.

TABLE 6.3

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR RESIDUE, SOIL, AND WATER SAMPLES

RESIDUE AND SOIL SAMPLES			
Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 250ml wide-mouth glass jar	Cool, 4 degrees C	180 days
Cyanide	1 x250ml wide-mouth glass jar	Cool, 4 degress C	14 days
TCL Volatiles	2 x 125ml wide-mouth Teflon-lined jar	Cool, 4 degees C	7 days
TCL Semivolatiles	1 x 250ml wide-mouth Teflon-lined jar	Cool, 4 degrees ction	7 days until extraction 40 days after extraction
Radionuclides	1 x 1l Wide-mouth glass jar	None	180 days
TOC, Anions, pH, and specific conductance	1 x 250ml wide-mouth glass jar	Cool, 4 degrees C	28 days

WATER SAMPLES			
Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 1l polyethylene bottle	Nitric acid pH<2; Cool, 4 degrees C	180 days
Cyanide	1 x 1l polyethylene bottle	Sodium hydroxide pH>12; Cool, 4 degrees C	14 days
TCL Volatiles	2 x 40ml VOA vials with teflon-lined septum lids	Cool, 4 degrees C	7 days
TCL Semivolatiles	1 x 4l amber glass bottle	Cool, 4 degrees C	7 days until extraction, 40 days after extraction
Radionuclides	12l polyethylene bottles(s)	Nitric acid pH<2; Cool, 4 degrees C	180 days
TOC	1 x 250ml polytehylene bottle	Sulfuric acid pH<2; Cool, 4 degrees C	28 days
Anions	1 x 1l polyethylene bottle	Cool, 4 degrees C	28 days
Nitrate/Nitrite	1 x 250ml polyethylene bottle	Sulfuric acid pH<2; Cool, 4 degrees C	28 days
pH, temperature, and specific conductance	In-situ, beaker, or bucket	None	Analyze immediatley

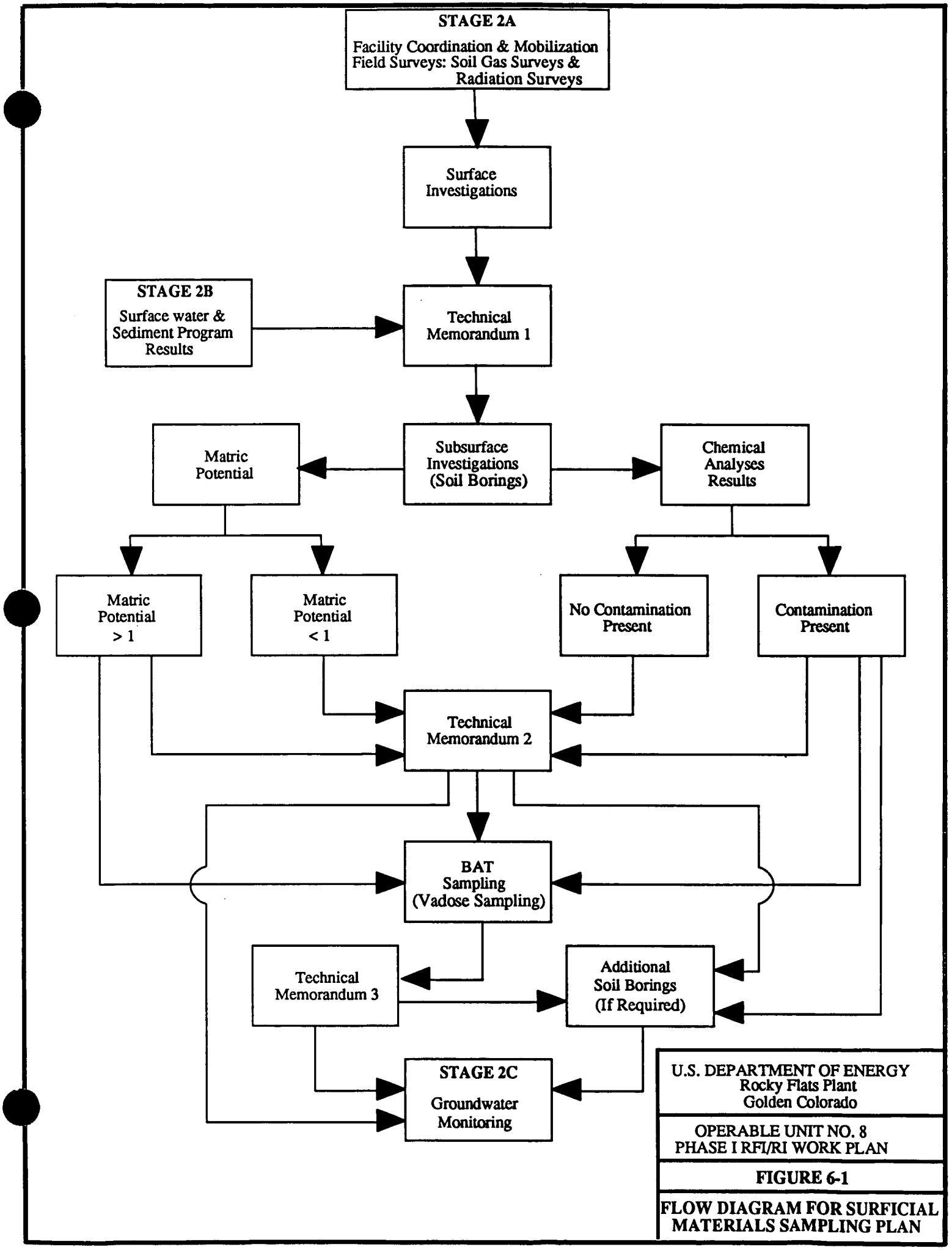
Holding time for mercury is 28 days.

TABLE 6.4

FIELD QC SAMPLE FREQUENCY

SAMPLE TYPE	TYPE OF ANALYSIS	SAMPLE FREQUENCY SOLIDS	SAMPLE FREQUENCY LIQUIDS
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Banks	Organics	N/R	N/R
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Equipment Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics	1/20	1/20
	Inorganics	N/A	N/A
	Radionuclides	N/A	N/A

N/A = Not Applicable
N/R = Not Required
1/10 = one QC sample per ten samples collected


STAGE 2A
Facility Coordination & Mobilization
Field Surveys: Soil Gas Surveys &
Radiation Surveys
Surface Investigations
STAGE 2B
Surface water & Sediment Program Results
Technical Memorandum 1
Matric Potential
Subsurface Investigations (Soil Borings)
Chemical Analyses Results
Matric Potential > 1
Matric Potential < 1
No Contamination Present
Contamination Present
Technical Memorandum 2
BAT Sampling (Vadose Sampling)
Technical Memorandum 3
Additional Soil Borings (If Required)
STAGE 2C
Groundwater Monitoring
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado
OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN
FIGURE 6-1
FLOW DIAGRAM FOR SURFICIAL MATERIALS SAMPLING PLAN

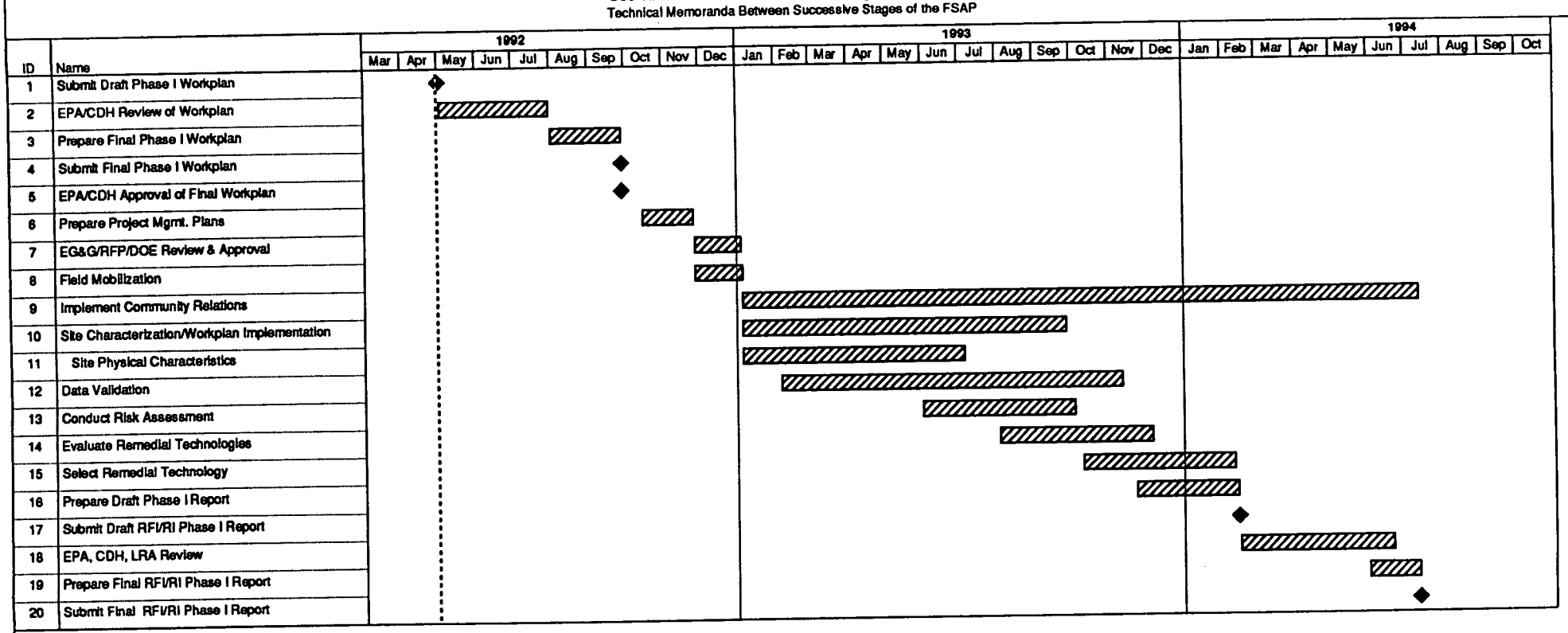
7.0 TASKS AND SCHEDULING

The preliminary schedule for conducting the OU8 Phase I RFI/RI is summarized in Figure 7-1. The preliminary schedule includes the milestones established in Attachment 2, Table 6 of the IAG (Appendix A). An estimated one and one half years will elapse from the time the Work Plan is implemented until a final report of the RFI/RI Phase I investigation is issued. The schedule addresses contingencies related to regulatory review of Technical Memoranda between successive stages of the FSAP, but it does not address scheduling issues related to obtaining contractual authorization to proceed.

Several key elements of the Work Plan overlap chronologically. This reflects both the flexibility designed into the Work Plan and the need to implement the Work Plan on an aggressive schedule.

Data validation will begin approximately one month after the site characterization task begins. Implementing data validation concurrent with site characterization will assist in the refinement of data collection procedures and in completing RFI/RI activities within the timeframe established in the IAG.

OU8 RFI/RI Schedule Includes Time for Regulatory Review of
Technical Memoranda Between Successive Stages of the FSAP



Project: OU8 RFI/RI Schedule
Date: 4/20/92

Critical Noncritical Progress Milestone Summary

FIGURE 7-1
OPERABLE UNIT 8 RFI/RI SCHEDULE

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

8.0 HUMAN HEALTH ASSESSMENT PLAN

Following implementation of this Work Plan and validation of all acquired data, a baseline risk assessment (BRA) will be conducted to evaluate potential threats to human health and the environment from constituents associated with the Rocky Flats OU8 and/or IHSS sites contained within the unit boundary (Figure 8-1). Soil and potentially sediments, vadose water, and groundwater at OU8 site has been shown to contain VOCs, semivolatiles, metals, and some radionuclides. Aromatic and halogenated VOCs have been found at low concentrations in the shallow groundwater. The BRA will evaluate the potential impact of OU8-associated constituents on health and the environment and derive clean-up goals which may guide the selection of remediation technologies.

8.1 APPROACH

The BRA will follow procedures published in the U.S. Environmental Protection Agency (EPA) *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (EPA, 1989c) and Volume II, *Environmental Evaluation Manual* (EPA, 1989d), referred to as the RAGS. Other guidance documents will include, but not be limited to, *The Risk Assessment Guidelines for 1986* (EPA, 1987a) and the *Superfund Exposure Assessment Manual* (EPA, 1988a).

The human health risk assessment will be conducted in four phases including: 1) an identification of compounds of potential concern, 2) an exposure assessment, 3) a toxicity assessment, and 4) a risk characterization with an uncertainty analysis. The following tasks will be completed during the four phases.

Data Collection and Evaluation

- Identify or verify indicator chemicals from existing OU8 data;
- Contaminants of Concern Screening (COCS);

Exposure Assessment Phase

- Characterize potential contaminant migration pathways through environmental media;
- Identify locations where contaminant contact with humans or other receptors might occur;
- Calculate human and other receptor exposure doses at the contact points; and
- Uncertainty analysis.

Toxicity Assessment Phase

- Identify or derive reference doses for non-carcinogens;
- Identify carcinogens, their EPA classification, and their potency slopes (slope factors);

Risk Characterization Phase

- Evaluate the potential noncarcinogenic and carcinogenic (cancer-causing) health impacts associated with estimated receptor exposure levels. Refine assumptions as necessary;
- Conduct qualitative or quantitative uncertainty analysis;
- If acceptable levels are exceeded, identify:

  - impacted receptors and characterize possible impact,
  - responsible constituents,
  - responsible migration pathways,
  - responsible routes of exposure; and

- If acceptable levels are exceeded, calculate health-based cleanup levels; and
- Characterize uncertainty.

8.2 DATA COLLECTION EVALUATION AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

Historical analytical data from OU8, as well as data derived from implementation of this Work Plan, will be used to determine which constituents should be evaluated during the risk assessment. Only data meeting criteria described in the RAGS will be used. Constituents not exceeding background concentrations will be eliminated so that risks contributed by off-site sources will not be included. A constituent may also be eliminated that is: 1) detected with very low frequency, 2) is not highly toxic, 3) not mobile, or, 4) not persistent in the environment and, 5) has no tendency to bioaccumulate. Remaining constituents consistently detected at elevated concentrations will be included in the assessment as "chemicals of potential concern."

8.3 TOXICITY ASSESSMENT

The toxicity of the chemicals of potential concern will be evaluated and briefly described. Critical target organs and/or toxic effects will be reported. Reference doses (RfDs), also known as acceptable daily intakes, for noncarcinogenic effects will be reported from the EPA Integrated Risk Information System (IRIS). If not located in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST) will be consulted. If no RfD is available from either source, an RfD from a chemical with similar molecular structure may be used. If necessary, a contractor-derived RfD may be generated from the primary toxicology literature. Such a derivation will be part of the report and will be appropriately referenced. Similarly, cancer potency slopes (CPSs) will also be reported from IRIS or the HEAST for carcinogenic chemicals of potential concern; or, CPSs from structurally similar chemicals will be used.

Because the health risk from a chemical of potential concern is dependent on the likelihood of exposure as well as its intrinsic toxicity, physical and chemical properties and fate data will be gathered during this effort. On-line databases of chemical library information will be accessed to acquire toxicity and fate data.

8.4 EXPOSURE ASSESSMENT

In this task, potential chemical migration pathways, potentially exposed population(s), and possible chemical contact locations will be identified and characterized. In order to define chemical migration pathways from sources to contact locations, contaminant fate, and transfer through the various environmental media will be evaluated. Characterization of these pathways is ultimately intended to define the concentration of chemicals of potential concern at the contact locations.

Once general patterns of contaminant movement are defined, a more rigorous ranking of potential locations where receptors could contact constituents will follow. Once plausible contact locations are identified, constituent concentrations at these points will be defined from analytical chemistry data, or predicted from source concentrations with the use of fate and transport models. It may be necessary to use fate and transport models to convert source concentrations of the various constituents into concentrations at the contact points. For example, it may be necessary to model the fate and transport of ground and surface waters to estimate concentrations in various media at receptor/contaminant contact locations. Next the concentration at the contact location will be converted into an intake or dose to the receptor using algorithms that account for; 1) visiting frequency, 2) mode and magnitude of contact with the contaminated medium, 3) route of exposure of the receptor with the contaminated medium, and, 4) absorption rate from the contaminated medium into the receptor.

Possible on- or off-site points where contact with chemicals might occur could include exposed source areas, drainage ditches, footing drain outfalls, creek bottoms, surface water bodies, and other locations identified in the conceptual model for OU8 that might collect contaminated soil or leachate from surface runoff. Other potential contact points could include down-gradient wells and down-wind residences.

Knowledge of on-site and surrounding current and future land use practices will permit the identification of receptor populations which may be impacted by exposure to OU8 contaminants now or in the future. For the baseline case, on-site receptors may include employees, security guards, other personnel who visit or maintain OU8, and occasional visitors. Off-site receptors for the baseline case could include downstream boaters/swimmers/fish consumers and residents using municipal water with intakes downstream from OU8. In addition, the aquatic life in nearby surface water bodies constitute potential environmental receptors as do indigenous terrestrial wildlife. Of especial concern is the possible impact of chemicals of potential concern on any endangered or threatened species indigenous to the area. Evaluation of future land use scenarios, as required in the Statement of Work for this BRA, may result in the identification of other potentially exposed contact locations and receptors.

For on-site personnel, direct contact with contaminated soil is possible via incidental ingestion (e.g., eating a meal without washing hands) and dermal absorption. In addition, these receptors may inhale contaminants directly volatilized or adsorbed onto windblown dust. Downwind residents could comprise another category of receptors, as could downgradient well users for either domestic or agricultural purposes. For a downstream resident using municipal water, routes of exposure could include ingestion from drinking municipal water and dermal absorption while showering. If runoff contaminates water supplies for domestic animals, bioaccumulation may occur and consumers exposed. Individuals who hunt or who fish the waters adjacent and downstream from OU8 may be exposed via wildlife consumption.

Receptor doses will be estimated using algorithms that convert environmental concentrations into doses. These algorithms account for contact frequency, duration, the route of exposure (i.e., inhalation, dermal, ingestion), and other conditions of exposure (e.g., for dermal absorption; amount of skin exposed, amount of soil retained on skin, percent of chemical absorbed from soil through skin and into receptor).

8.5 UNCERTAINTY IN RISK CHARACTERIZATION

Uncertainties in Risk Characterization

The numbers and kinds of uncertainties identified in the Human Health Risk Assessment directly impact the interpretation of estimated risks developed in this section. Quantitative risk estimates derived in risk assessments are conditional estimated that include numerous assumptions about exposures and toxicity. Uncertainty is introduced from a variety of sources, including, but not limited, to the following sources:

- Sampling and analysis
- Exposure estimation
- Toxicological data

As stated in the RAG (EPA, 1989a), a highly quantitative statistical uncertainty analysis is usually not practical or necessary for site risk assessments. As in all environmental risk assessments, it is already known that the uncertainty about the numerical results is large. Consequently, it is more important to identify the key site-related variables and assumptions that contribute most to the uncertainty than to precisely quantify the degree of uncertainty in the risk assessment.

At a minimum, uncertainty will be described qualitatively in terms of under-or-over-estimation of risk, or both. If possible, uncertainty may be described quantitatively using sensitivity using sensitivity analyses or other numerical models.

8.6 RISK CHARACTERIZATION

In this final step of the BRA, the exposure and toxicity data will be integrated to provide an estimate of the risk associated with overall exposure. The doses estimated in the exposure

assessment will be compared to the acceptable doses defined in the toxicity assessment. Non-cancer risk is expressed as a ratio of estimated to acceptable doses called a hazard index. Cancer risk is expressed as the 95% upper bound estimate of the probability of developing cancer after exposure to the estimated dose for a 70-year lifetime. In addition, risk will be assessed separately for each exposure pathway for each scenario. This allows identification of the pathway(s) and chemical(s) that are the most important contributor to the total risk for a particular constituent, as well as for a particular medium. In turn, this information is used to guide remediation efforts.

Estimation of Non-cancer Risks: Once doses have been estimated, they will be compared to acceptable doses for non-cancer effects as defined by: (1) the EPA (in the form of reference doses or RfDs); (2) other regulatory agencies; or (3) scientific authorities, such as the National Academy of Science. The hazard quotient of a constituent is the ratio of the daily intake rate divided by that chemical's reference dose.

Individual hazard quotients will be summed for all chemicals of potential concern to derive an overall hazard index that takes into account the possibility of additive effects from pollutants producing the same toxic effect in the body (or affecting the same organ). If the overall hazard index is less than 1.0, then estimated doses will be less than acceptable doses and it may be concluded that no non-cancer health threat exists under the exposure conditions evaluated. If estimated doses are higher than acceptable levels, chemicals will be categorized according to toxicity effect, and hazard indices will be calculated individually for each toxic effect. If one or more toxic effects still reflect a hazard index greater than one, a non-cancer health threat may exist. The critically impacted receptor(s) incurring this risk, the route of exposure, the migration or contact pathway, and clean-up goals would then be identified for remediation.

Estimation of Cancer Risks: Doses estimated in the exposure assessment will be multiplied by the EPA-derived cancer potency slope (CPS) for any carcinogen(s) associated with OU8. The resulting value represents a 95% upper-bound estimate of the probability of contracting cancer

if exposed daily to a carcinogen at its estimated dose for a 70-year lifetime or, for a dose incurred for a shorter interval but averaged over a 70-year lifetime. If more than one carcinogen is associated with OU8, risks will be added to derive an overall risk.

8.7 UNCERTAINTY ANALYSIS

An uncertainty analysis will also be conducted as part of the risk characterization section. The uncertainty analysis will assess the conservatism or non-conservatism of the assumptions used in the BRA. This may be either a qualitative or quantitative exercise. The impacts of other possible assumption values may also be discussed, also either qualitatively or quantitatively, in what is termed a sensitivity analysis. In this way, the assumptions most influencing the results of the risk assessment may be identified and refined if appropriate. Assumptions may be refined (i.e., more accurate values may be obtained, usually at the cost of more time and effort) in order to derive more accurate estimates of risk. This process of assumption refinement (using more accurate estimates rather than conservative "default" values) usually has the tendency to lower estimated risks.

For this risk assessment, a program called @Risk (pronounced, "At Risk;" Palisade Corp., Newfield, NY) may be used to attempt a quantitative evaluation of uncertainty using Monte Carlo or Latin Hypercube analysis. It should be noted, however, that the usefulness of this attempt depends entirely on the assumed statistical distribution of the assumptions used in the risk assessment. Most usually, very little data is available by which to assign such distributions. For example, whether the ingestion of soil by children is distributed normally, log-normally, or otherwise is not known with any certainty. In such situations, a log-normal distribution often is assumed (usually, for this specific parameter, a discrete value of 200 mg/event is assumed). Therefore, the value of an uncertainty analysis may lie mostly in the qualitative descriptions of the variation of, or uncertainty about, the component assumptions, rather than in a actual quantitative measure of uncertainty.

8.8 DERIVATION OF CLEANUP GOALS

If desired, clean-up goals may be derived both from the hazard index for noncarcinogenic risks and from the 95% upper-bound estimate of the CPS for potential carcinogens. When derived for noncarcinogens, target clean-up levels will be identified resulting in an overall hazard index of 1.0. The resulting media concentrations correspond to estimated doses which do not exceed acceptable doses for non-cancer effects.

For carcinogens, alternative clean-up concentrations may be derived which correspond to cancer risk levels ranging from 1 in 1,000,000 to 1 in 10,000. Usually, the clean-up level derived for a chemical's carcinogenic effects is lower than that for its noncarcinogenic effects. As a result, levels based on cancer-causing potential more likely will be used as target cleanup concentrations, depending upon the level of risk to which OU8 will be controlled.

8.9 ECOLOGICAL RISK ASSESSMENT

Endangered/threatened species indigenous to the area will be identified and the basis for the threat to these species will be ascertained. If the species are compromised due to over-hunting, habitat destruction, or other non-chemical related factors, then chemicals associated with OU8 may be judged not to constitute a threat. If the species are compromised due to chemicals (e.g., DDT and the bald eagle), then the nature of the chemicals associated with the OU8 will be compared to that known to compromise the species. In the latter case, doses will be estimated and compared to acceptable exposures for that species, if available.

8.10 RISKS FROM RADIONUCLIDES

The components of radiation risk assessment are virtually identical for the exposure assessment portion of the risk assessment. The only difference is the way in which dose is defined. For chemicals, the estimated dose is defined in terms of mass of the chemical per unit of body

weight. For radiation, dose is defined as the amount of energy imparted per unit of body weight. The acceptable dose for radionuclides is similarly different from chemicals in the toxicity assessment phase. In addition, radioactive substances may present an external hazard, unlike chemicals. Other parts of the radiological portion of the risk assessment are similar (e.g., the risk characterization "compares" the estimated and acceptable doses).

8.11 RISK ASSESSMENT REPORT

The methodology and results of the risk assessment will be incorporated into the risk assessment report. Draft and final reports will be submitted for appropriate review and comment by DOE, EG&G, and regulatory agencies involved in the Phase 1 RFI/RI for OU8. The BRA report will contain all supporting figures, tables, and references necessary to document the results of the BRA.

9.0 ENVIRONMENTAL EVALUATION WORK PLAN

9.1 INTRODUCTION

OU8 lies entirely within the production area at RFP in areas surrounding the building complexes 300 and 700. This area has been developed to such an extent that there are no viable ecosystems or natural habitats. There are insufficient ecosystems, components, or functions existing on OU8 to require or allow a comprehensive ecological risk assessment. OU8 overlaps with several other plant site OUs and is largely included within the OU9 ecological study area, which extends throughout most of the production area. The OU9 Environmental Evaluation (EE) Work Plan provides for an ecological risk evaluation of the production area focused on requirements appropriate for the depauperate ecosystems that exist there. The objective of the OU8 EE is to address and characterize any potential for adverse impacts to ecosystems or ecological resources present or at other locations and then to determine if there is a risk of contamination via abiotic or biotic transport.

Coordination of OU8 EE requirements with the OU9 EE is required due to the overlapping study areas. Habitat and biological surveys proposed for OU9 will cover the entire industrial area, and as a result will apply to OU8. Following is a brief description of the study components proposed for OU9 and how these studies relate to the OU8 EE. This description is based on a preliminary draft of a technical memorandum for OU9 (EG&G, 1992).

9.2 BIOLOGICAL AND HABITAT SITE CHARACTERIZATION

Biota and habitat surveys proposed for OU9 will be adequate for the biological and habitat characterization of OU8 and will not be duplicated or repeated. Based on OU9, potential target taxa including migratory birds are listed in Table 9.1. These surveys will provide the following information applicable to OU8:

- Comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support migratory birds;
- Presence and/or use of habitats by raptors and migratory birds, including waterfowl and passerine species;
- Presence or absence of threatened and endangered species, or species of special concern; and
- Data on small and large mammal or bird population dynamics, if present.

This characterization will include a literature review, expert consultation, and field surveys for 1) vegetation, 2) species of special concern, 3) small and large mammals, and 4) birds. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within OU8. This information will be included in the following three reports:

- Habitat survey report for compliance with acts for protection of migratory birds;
- Biological survey report for compliance with acts and regulations protecting threatened and endangered species; and
- Reporting of results of small and large mammals and bird surveys.

9.3 ECOTOXICOLOGICAL INVESTIGATIONS

Ecotoxicological investigations will be conducted if the following conditions are present on OU8.

- If target taxa are present on the study area and could accumulate or concentrate target analytes; and either
- The contaminated target taxa are capable of migration outside the OU8 study boundaries; or
- The contaminated target taxa are highly mobile and actually move outside the study or industrial area boundaries.

If the above conditions are not met, then it is presumed that there is no risk of contamination of offsite biota from OU8.

If an ecotoxicological investigation is necessary, it would consist of the following procedures:

- Developing a site-specific Conceptual Exposure Model to identify potential pathways for exposure of onsite biota;
- Developing a Conceptual Biota Transport model to identify potential pathways for offsite transport;
- Selection of target taxa and target analytes (biologically active COCs); and
- Direct measurement of target analytes within target taxa.

A Technical Memorandum will be prepared and submitted for EPA and CDH review and approval and U.S. Fish and Wildlife Surface and Colorado Department of Wildlife review prior to initiating any work.

The procedures for conducting this type of investigation for the industrial area are presently under development for OU9 and would be adapted, if needed, for the highly disturbed study area in OU8.

This information would be used to assess the ecological risk posed by contaminant migration by biological pathways. Information on contaminant migration by target taxa to other OUs will be provided to those OU managers for use in conducting their EEs for identifying ecological risks. This would be a quantitative estimate with the appropriate uncertainty analysis for model assumptions and estimates of parameters. This information would also be coordinated with contaminant migration by physical or abiotic media developed during the site characterization and transport models.

9.4 ENVIRONMENTAL EVALUATION REPORT

The EE portion of the BRA in the Phase I RFI/RI report will consist of the habitat survey, biological survey and small mammal and bird survey reports discussed in Section 9.2. If an ecotoxicological investigation is conducted in Phase I, the results could be included in the EE portion of the BRA in the Phase I RFI/RI report.

TABLE 9.1

POTENTIAL TARGET TAXA FOR ASSESSMENT OF ECOLOGICAL IMPACTS AT OU9

Category	Taxon
Mammals	Deer mouse
	House mouse
	Cottontail
Terrestrial invertebrates	Earthworms
	Arthropods
Grasses/forbs	Smooth brome
	Crested wheatgrass
	Cheatgrass
	Weeds species
Microbial Populations	Entire population

10.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND ADDENDUM

All work conducted in support of OU8 Phase I RFI/RI activities will be directed by the EG&G Environmental Management Department Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facilities Investigation/Corrective Measures Study Activities (QAPjP). The QAPjP complies with the requirements of EPA QAMS-005/80 and DOE Order 5700.6B which addresses NQA-1.

The QAPjP will be supplemented by a Quality Assurance Addendum (QAA) specific to OU8 and provided to ASI by EG&G for inclusion in the Work Plan after EG&G completes its review of a draft iteration of this Work Plan. The QAA will establish the specific Quality Assurance (QA) controls applicable to the field investigation activities described in the Plan.

The QAA provided by EG&G that will guide the activities presented in this Work Plan are presented on the following pages in this section.

Approved by:

_____	___/___/___	_____	___/___/___
Manager, Remediation Programs		RFI Project Manager	

10.1 QUALITY ASSURANCE ADDENDUM

This section consists of the Quality Assurance Addendum (QAA) for Phase I investigations at Operable Unit No. 8 (OU8), which supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP). This QAA establishes the site-specific Quality Assurance (QA) controls applicable to the investigation activities described in the OU8 Work Plan (OU8 WP).

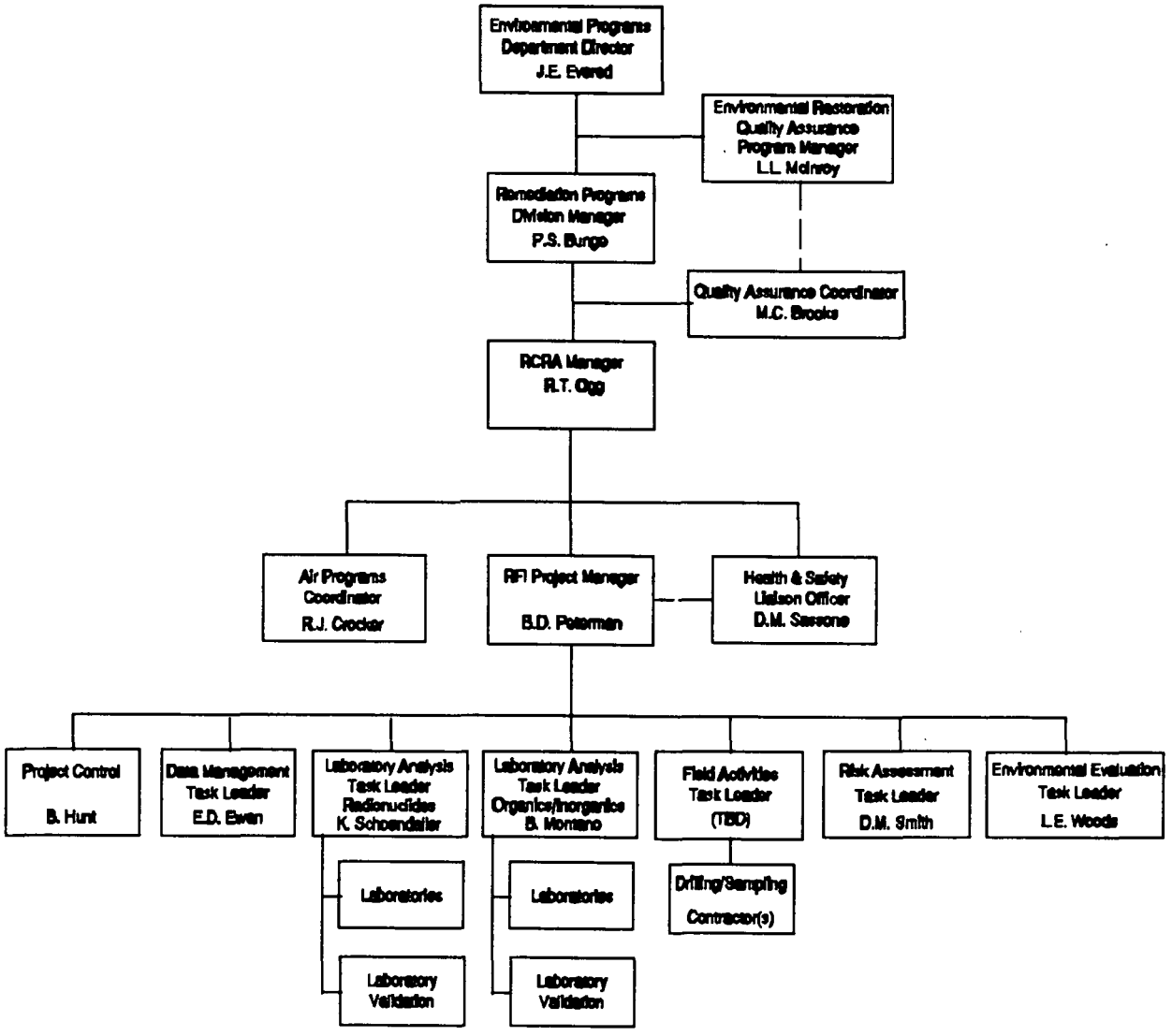
OU8 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG). OU8 contains 38 individual hazardous substance sites (IHSSs), which are described in Section 2.4 of the OU8 WP. Section 2.5 describes the nature and extent of contamination at the IHSSs within OU8. The OU8 WP was prepared in accordance with EPA/530/SW-89-031, RCRA Facility Investigation (RFI) Guidance (May 1989), EPA/540/8-89/004, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (October 1988), and the IAG.

10.1.1 ORGANIZATION AND RESPONSIBILITIES

The overall organization of EG&G Rocky Flats and the Environmental Management Department (EMD) and divisions involved in Environmental Restoration (ER) Program activities is shown in Figures 1-1, 1-2, and 1-3 of Section 1.0 of the QAPjP. Individual responsibilities are also described in Section 1.0 of the (QAPjP).

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU8 WP. The specific EMD personnel who will interface with the Contractors and who will provide technical direction are shown in Figure 10-1.

FIGURE 10-1. PROJECT MANAGEMENT FOR OPERABLE UNIT 8 700 AREA, PHASE I RFI/RI



10.1.2 QUALITY ASSURANCE PROGRAM

The QAPjP was written to address QA controls and requirements for implementing IAG-related activities. The content of the QAPjP was driven by Department of Energy (DOE) RFP Standard Operating Procedure (SOP) 5700.6B, which requires a QA program to be implemented for all RFP activities based on American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facilities," as wall as the IAG, which specifies that a QAPjP for IAG-related activities be developed in accordance with EPA/QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAAs with the applicable elements of QAMS-005/80 incorporated where appropriate. Figure 2-1 of the QAPjP illustrates where the 16 QA elements of QAMS-005/80 are integrated into the QAPjP and also into this QAA. Section 2.0 of the QAPjP also identifies other DOE Orders and QA requirements documents to which the QAPjP and this QAA are responsive.

The controls and requirements addressed in the QAPjP are applicable to OU8 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU8 activities, the applicable section of the QAPjP is referenced in this QAA. This QAA addresses additional and site-specific QA controls and requirements that are applicable to OU8 Phase I activities that may not have been addressed on a site-wide basis in the QAPjP. Many of the QA requirements specific to OU8 are addressed within other section of the OU8 WP and are referenced in this QAA.

10.1.2.1 Training

Personnel qualification and training requirements for RFP ER Program activities are addressed in Section 2.0 of the QAPjP. Personnel qualifications and training required to perform the EMD Operating Procedures (OPS) and Environmental Management Radiological Guidelines (EMRGs)

that are applicable to OU8 investigations are specified within the respective procedures. The EMD OPS (which may also be referred to as EM Standard Operating Procedures [SOPs] in the QAPjP and the OU8 WP) and EMRGs that are applicable to Phase I activities at OU8 are identified in Table 10.1.

TABLE 10.1

EMD Operating Procedures and Field Activities for Which they are Applicable

Former SOP Reference Numbers	EMAD OPS Reference Numbers	Standard Operating Procedures	Field Radiation Surveys	Well Drilling	Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling
1.1	FO.01	Wind Blown Contaminant Dispersion Control						●	
1.2	FO.02	Field Document Control	●	●	●	●	●	●	●
1.3	FO.03	General Equipment Decontamination	●	●	●	●	●	●	●
1.4	FO.04	Heavy Equipment Decontamination		●	●			●	
1.5	FO.05	Handling of Purge and Development Water		●	●				
1.6	FO.06	Handling of Personal Protective Equipment	●	●	●	●	●	●	●
1.7	FO.07	Handling of Decontamination Water & Wash Water	●	●	●	●	●	●	●
1.8	FO.08	Handling of Drilling Fluids & Cuttings		●					●
1.9	FO.09	Handling of Residual Samples						●	●
1.10	FO.10	Receiving, Labeling, and Handling Waste Containers		●	●				●
1.11	FO.11	Field Communications	●	●	●	●	●	●	●
1.12	FO.12	Decontamination Facility Operations	●	●	●	●	●	●	●
1.13	FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples			●	●	●	●	●
1.14	FO.14	Field Data Management	●	●	●	●	●	●	●
1.15	FO.15	Use of PIDs and FIDs		X	X	X	X	X	X
1.16	FO.16	Field Radiological Measurements a) Walk-Over Surveys	●	X	X	X	X	X	X
New	FO.18	Environmental Sample Radioactivity Content Screening				●		●	●
2.1	GW.01	Water Level Measurements in Wells and Piezometers		●	●				
2.2	GW.02	Well Development		●					
2.5	GW.03	Measurements for Groundwater Field Parameters			●				
2.6	GW.04	Groundwater Sampling			●				

X-As required by H&S plan.

TABLE 10.1 - (Continued)

EMD Operating Procedures and Field Activities for Which they are Applicable

Former SOP Reference Numbers	EMAD OPS Reference Numbers	Standard Operating Procedures	Field Radiation Surveys	Well Drilling	Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling
3.1	GT.01	Logging Alluvial and Bedrock Material		●					●
3.2	GT.02	Drilling and Sampling Using Hollow-Stem Auger Techniques		●					●
3.3	GT.03	Isolating Bedrock from the Alluvium with Surface Casing		●					●
3.5	GT.05	Plugging and Abandonment of Boreholes		●					●
3.6	GT.06	Monitoring Well and Piezometer Installation		●					
3.8	GT.08	Surface Soil Sampling						●	
3.9	GT.09	Soil Gas Sampling and Field Analysis							
3.10	GT.10	Borehole Clearing		●					●
New	GT.15	Geophysical Borehole Logging		●					●
New	GT.17	Land Surveying		●					●
New	GT.19	Field Gas Chromatographs					●		
New	GT.22	BAT In-Situ Sampler (Proposed)				●			
EMRG OPS Reference No.									
1.1		Gamma Radiation Surveys	●						
1.2		Beta Radiation Surveys	●						
3.2		Survey Requirements for Conditional and Unrestricted Use	●						

10.1.2.2 Quality Assurance Reports to Management

A QA summary report will be prepared annually or at the conclusion of these activities (whichever is more frequent) by the EMD Quality Assurance Project Manager (QAPM) or designee. This report will include a summary of field operation and laboratory inspections, surveillance, and audits and a report on data verification/validation results.

10.1.3 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

10.1.3.1 Design Control

The OU8 WP describes the investigation activities that will be implemented during the Phase I characterization of the OU8 IHSSs. The OU8 WP identifies the objectives of the investigations; specifies the sampling, analysis, and data generation requirements; and identifies applicable operating procedures that will provide controls for the investigations. As such, the OU8 WP is considered the investigation control plan for OU8 Phase I RFI/RI activities.

10.1.3.2 Data Quality Objectives

The development of Data Quality Objectives (DQOs) for the OU8 Phase I investigations is presented in Section 5.2 of the OU8 WP. The DQOs for OU8 were established in accordance with 3-stage process described in EPA/540/G-87/003 (OSWER Directive 9355.0-7B), Data Quality Objectives for Remedial Response Activities, and Appendix A of the QAPjP.

Identifying data quality needs begins with defining investigation objectives and identifying data uses and the types of data to be collected. Phase 1 investigation objectives, data uses and data quality objectives (DQOs) for OU8 are defined in Section 5.2. Other factors that are necessary

in identifying data quality needs include selecting appropriate analytical levels, contaminants of concern, levels of concern, required detection limits, and critical samples. The analytical levels, contaminants of concern, levels of concern, and required detection limits are presented in Section 5 of the OU8 WP.

Data quality can be measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). Precision, accuracy, and completeness are quantitative measures of data quality, while representativeness and comparability are qualitative statements that express the degree to which sample data represent actual conditions and describe the confidence of one data set to another. These parameters are defined in Appendix A of the QAPjP. PARCC parameters will be determined for OU8 Phase I investigations as described previously in Section 5. PARCC parameter goals are established prior to initiating investigations in order to assist decision makers in determining if DQOs for measurement data have been met. The goals for precision and accuracy for the contaminants of concern identified in Table 5.2-4 are presented in Table 10.2. The goal for completeness is 100 percent with a minimum acceptable completeness of 90 percent for laboratory measurement data and 80 percent for field measurements.

Based on the data quality needs identified for OU8 Phase I investigations, the sampling and analytical options were evaluated. The sampling and analytical methods selected for OU8 Phase I investigations are listed in Table 5.2-4. The specific field analytical methods and the Standard EPA and EPA CLP laboratory methods are identified in Table 10.2.

10.1.3.3 Sampling Locations and Sampling Procedures

The sampling plan for OU8 is described in Section 6 of the OU8 WP. Sampling activities will be staged, with the initial stages providing information that will be used to direct and refine

sampling methods and location in subsequent stages. The field sampling plan for OU8 is summarized in Table 6.1.

The operating procedures that are applicable to OU8 Phase I field activities and the particular activities to which they are applicable are summarized in Table 10.1.

10.1.3.4 Analytical Procedures

The analytical program for OU8 Phase I RFI/RI investigation is discussed in Section 6.5.6. The analytes of interest and the specified detection limits for radiation surveys, surface scrape radiochemistry, soil gas sampling, subsurface (borehole) soil sampling, shallow soil sampling, alluvial groundwater sampling, asphalt sampling, and surface wipe sampling for each IHSS are identified in Table 6.3. The analytical methods that shall be adhered to are those that are specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each analyte identified in Table 6.3 are referenced in Table 10.2.

10.1.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i.e., sampling equipment that is used at more than one location) shall be decontaminated between sampling locations in accordance with OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, boring, well installation, sample collection, etc. shall be decontaminated as specified in OPS-FO.04, Heavy Equipment Decontamination.

10.3.6 Air Quality

Air monitoring will be conducted during implementation of field activities that have the potential to create windblown dispersion of contaminants, including drilling, coring, and installation of boreholes and monitoring wells. Air monitoring will ensure that OU8 RFI/RI activities comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air monitoring will be conducted according to OPS-FO.01, Wind Blown Contaminant Dispersion Control.

10.1.3.7 Quality Control

To ensure the quality of the field sampling techniques, collection and/or preparation of field quality control (QC) samples are incorporated into the sampling scheme. Field QC samples and collection frequencies for OU8 are addressed in Section 6.5.4 and are identified in Table 6.4. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 10-1) prior to sampling.

Objectives for Field QC Samples:

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 5.3. Equipment rinsate blanks may only be analyzed if contaminants of concern are detected above background in samples. Field duplicate samples shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Table 5.3. The Laboratory Analysis Task Leader (Figure 10-1) is responsible for

verifying these criteria and shall be responsible for checking to see if they are met and for qualifying data.

Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency of analytical and storage procedures. The laboratory contractor will submit written SOPs to the Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC procedures. The laboratory SOPs must cover the following areas in sufficient detail and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in
- Sample storage and security
- Facility security
- Sample tracking (from receipt to sample disposition)
- Sample analysis method references
- Data reduction, verification, and reporting
- Document control (including submitting documents to EG&G)
- Data package assembly (see Section III.A of the GRRASP)
- Qualifications of personnel
- Preparation of standards
- Equipment maintenance and calibration
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any)
- Instrument detection limits
- Acceptance criteria for non-CLP analyses
- Laboratory QC checks applicable to each analytical method

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory replicate analysis, and field duplicates. The laboratory contractor will follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method being used as specified in Parts A and B of the GRRASP and Section 3.0 of the QAPjP. All data packages will be forwarded to the Laboratory Analysis Task Leader or validation contractor (Figure 10-1) for review and verification.

10.1.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU8 WP, field inspections will be conducted daily and audits and surveillance will be conducted at various intervals. The intervals will be determined by the importance and complexity of each activity. Intervals will also be based on the schedule contained in Section 7.0. At a minimum, each of the field sampling activities described in Sections 6.4 will be monitored by an independent surveillance team at least once during the sampling process. EG&G will conduct audits of the laboratory contractor(s) as specified in the GRRASP, Parts A and B. The audits and surveillance, and activity Readiness Reviews are discussed further in Section 6.6.18.

10.1.3.9 Data Reduction, Validation, and Reporting

Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3-1 of Section 3.0 of the QAPjP.

Data Reduction

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Laboratory data will be compiled into sample data packages by the laboratory contractor. A sample data package shall be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis (e.g., a data package for organics, one for inorganics, one for water quality parameters, and one for radionuclides). The sample data package shall consist of a cover sheet/transmittal letter, a case narrative, data summary forms, and copies of the data checklists found in Attachments I in Parts A and B of the GRRASP. The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met.

Data Validation

Validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality (i.e., comparison of reduced data to DQOs, where appropriate). The field and laboratory data validation activities and guidelines are described and referenced in Section 3.0 of the QAPjP. The process for validating the quality of the data is illustrated graphically in Figure 3-1 of Section 3.0 of the QAPjP, and is also included as part of the sample collection, chain-of-custody, and analysis process illustrated in Figure 8-1 of Section 8.0 of the QAPjP. The criteria for determining the validity of ER data at Rocky Flats are described in subsection 3.3.7 of Section 3.0 of the QAPjP.

Data Reporting

Depending on the data validation process, data are flagged as either "valid," "acceptable with qualifications," or "rejected." The results of the data validation shall be reported in ER Department Data Assessment Summary reports. The usability of data (the criteria of which is

also described in subsection 3.3.7 of Section 3.0 of the QAPjP) shall also be addressed by the RFI Project Manager.

10.1.4 PROCUREMENT DOCUMENT CONTROL

Procurement documents for items and services, including services for conducting field investigations and analytical laboratories, shall be prepared, handled, and controlled in accordance with the requirements and methods specified in Section 4.0 of the QAPjP.

10.1.5 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The OU8 WP describes the activities to be performed. The OU8 WP will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5.0 of the QAPjP.

EMD OPS approved for use are identified in Table 10.1, which also indicates their applicability. Any additional quality-affecting procedures proposed for use but not identified in Table 10.1 will be developed and approved as required by Section 5.0 of the QAPjP prior to performing the affected activity.

Changes and variances to approved operating procedures shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5.0 of the QAPjP. (Note: DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP). Any changes, revisions, additions, or deletions to the OU8 WP will be presented in either DCNs or Technical Memoranda. DCNs and Technical Memoranda will be reviewed and approved by the same organizations that reviewed and approved the original OU8 WP.

10.1.6 DOCUMENT CONTROL

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- "Phase I RFI/RI Work Plan for the 700 Area, Operable Unit No. 8"
- "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP)
- Quality Assurance Addendum (QAA) to the Rocky Flats Site-Wide QAPjP for Operable Unit No. 8, 700 Area, Phase I RFI/RI Activities
- EMD Operating Procedures and EM Radiological Guidelines (all operating procedures specified in this QAA and to-be-developed laboratory SOPs).

10.1.7 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors that provide services to support the OU8 WP activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes preaward evaluation/audit of proposed contractors as well as periodic audit of the acceptability of contractor performance during the life of the contract. Any items or materials that are purchased for use during the OU8 investigations that have the ability to affect the quality of the data shall be inspected upon receipt.

10.1.8 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

10.1.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples are presented in Table 6.3.

10.1.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Samples shall have unique identification that traces the sample to the source(s) and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling.

10.1.8.3 Chain-of-Custody

Sample chain-of-custody will be maintained through the application of OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, and as illustrated in Figure 8-1 of the QAPjP for all environmental samples collected during field investigations.

10.1.9 CONTROL OF PROCESSES

The overall process of collecting samples, performing analysis, and inputting the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. A process diagram is shown in Section 8.0 of the QAPjP.

10.1.10 INSPECTION

Procured materials and construction activities (e.g., groundwater monitoring well installation) shall be inspected in accordance with the requirements specified in Section 10.0 of the QAPjP.

10.1.11 TEST CONTROL

Test control requirements specified in Section 11.0 of the QAPjP are not applicable to any of the RFI/RI investigations described in the OU8 WP.

10.1.12 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

10.1.12.1 Field Equipment

Specific conductivity, temperature, and pH of groundwater samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-GW.05, Field Measurements for Groundwater Field Parameters. Measurements shall be made using the following equipment (or EG&G-approved alternatives):

- Temperature: mercury-filled, teflon-coated, safety-type thermometer (VWR catalogue No. 6107-832 or equivalent), or digital readout thermistor (VWR Catalogue No. 61017-562 or equivalent)
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- pH: HACH One pH Meter (this meter may also be used for temperature measurements)

In addition to the field measurements for water quality, field measurements for radiation and soil gas will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations. Beta/Gamma radiation will be measured with a Geiger-Muller shielded pancake detector, and Alpha radiation will be measured by a side shielded FIDLER. Use, calibration, and maintenance shall be according to EMRG OPS-1.1, 1.2 and 3.2. Walk-over radiation screenings shall also be performed for worker health and safety using a side shielded FIDLER according to OPS-FO.16, Field Radiological Measurements.

- Field readings for soil gas will be taken using a portable photoionization detector (PID), HNU Systems P1-101 or equivalent. Use, calibration, and maintenance according to OPS-FO.15, Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs).

Each piece of field equipment shall have a file that contains:

- Specific model and instrument serial number
- Operating instructions
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field
- Calibration methods, frequency, and description of the calibration solutions
- Standardization procedures (traceability to nationally recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

10.1.12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the

requirements contained in the specific analytical protocols used as specified in the GRRASP. This information will be supplied to EG&G as a laboratory SOP.

10.1.13 HANDLING, STORAGE, AND SHIPPING

Samples shall be packaged, transported, and stored in accordance with OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers are specified in Table 8-1 of Section 8.0 of the QAPjP. Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

10.1.14 STATUS OF INSPECTION, TEST, AND OPERATIONS

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section 14.0 of the QAPjP. A log specifying the status of all boreholes and groundwater monitoring wells shall be maintained by the Field Activities Task Leader, which will include well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

10.1.15 CONTROL OF NONCONFORMANCES

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data will be implemented as specified in Section 15.0 of the QAPjP. Nonconformances identified by the implementing contractor shall be submitted to EG&G for processing as outlined in the QAPjP.

10.1.16 CORRECTIVE ACTION

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 16.0 of the QAPjP. Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

10.1.17 QUALITY ASSURANCE RECORDS

QA records will be controlled in accordance with OPS-FO.02, Field Document Control. QA records to be generated during OU8 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for groundwater, sediment, and air)
- Calibration Records
- Sample Collection and Chain-of-Custody Records
- Laboratory Sample Data Packages
- Drilling Logs
- Work Plan/Field Sampling Plan
- QAPjP/QAA
- Audit/Surveillance/Inspection Reports
- Nonconformance Reports
- Corrective Action Documentation
- Data Validation Results
- Data Reports
- Procurement/Contracting Documentation
- Training/Qualification Records
- Inspection Records

10.1.18 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section 18.0 of the QAPjP. EG&G will conduct audits of the laboratory contractor as specified in the GRRASP, Parts A and B. The EMD QAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity. Intervals will also be based on the schedule contained in Section 7.0.

Examples of some specific tasks that will be monitored by the surveillance program are as follows:

- Borings and well installations (approximately 10 percent of the holes)
- Field sampling (approximately 5 percent of each type of sample collected)
- Records management (a surveillance will be conducted once at the initiation of OU8 activities, and monthly thereafter)
- Data verification, validation, and reporting

Audits of contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

A Readiness Review shall be conducted by the EMD QAPM prior to the implementation of OU8 field investigation activities. The readiness review will determine if all activity prerequisites that are required to begin work have been met. The applicable requirements of the QAPjP and this QAA will be addressed during the readiness review.

10.1.19 SOFTWARE CONTROL

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU8 WP activities. Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits Water	Required Detection Limits Soil	Precision Objective	Accuracy Objective
INDICATORS							
Total Organic Carbon	EPA 415[d] ASTM D4129-82	X[g]	X	5 mg/L		20%RPD[f]	80-120% LCS Recovery
INORGANICS							
Target Analyte List - Metals		X[f]	X			WATER/SOIL	WATER/SOIL
Aluminum	EPA CLP SOW[e]			200 ug/L[4]	40 mg/Kg[4]	**	***
Antimony	EPA CLP SOW[e]			60	12		
Arsenic (GFAA)	EPA CLP SOW[e]			10	2		
Barium	EPA CLP SOW[e]			200	40		
Beryllium	EPA CLP SOW[e]			5	1.0		
Cadmium	EPA CLP SOW[e]			5	1.0		
Calcium	EPA CLP SOW[e]			5000	2000		
Chromium	EPA CLP SOW[e]			10	2.0		
Cobalt	EPA CLP SOW[e]			50	10		
Copper	EPA CLP SOW[e]			25	5.0		
Cyanide	EPA 335.3 (modified for CLP)[e,d]			5	10		
Iron	EPA CLP SOW[e]			100	20		
Lead (GFAA)	EPA CLP SOW[e]			3	1.0		
Magnesium	EPA CLP SOW[e]			5000	2000		
Manganese	EPA CLP SOW[e]			15	3.0		
Mercury (CVAA)	EPA CLP SOW[e]			0.2	0.2		
Nickel	EPA CLP SOW[e]			40	8.0		
Potassium	EPA CLP SOW[e]			5000	2000		
Selenium (GFAA)	EPA CLP SOW[e]			5	1.0		
Silver	EPA CLP SOW[e]			10	2.0		
Sodium	EPA CLP SOW[e]			5000	2000		
Thallium (GFAA)	EPA CLP SOW[e]			10	2.0		
Vanadium	EPA CLP SOW[e]			50	10		
Zinc	EPA CLP SOW[e]			20	4.0		

TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits Water	Required Detection Limits Soil	Precision Objective	Accuracy Objective
ANIONS						Water/Soil	Water/Soil
Sulfate	EPA 375.4[d]		X				
Nitrate as N	EPA 353.2[d] or 353.3[d]	X[b]	X	1 mg/L		Same as Metals	Same as Metals
Fluoride	(TBD)		X				
Target Compound List - Volatiles		X[b]	X			WATER/SOIL	WATER/SOIL
Chloromethane	EPA CLP SOW[c]			10 ug/L	10 ug/Kg (low)[3]	**	***
Bromomethane	EPA CLP SOW[c]			10	10		
Vinyl Chloride	EPA CLP SOW[c]			10	10		
Chloroethane	EPA CLP SOW[c]			10	10		
Methylene Chloride	EPA CLP SOW[c]			5	5		
Acetone	EPA CLP SOW[c]			10	10		
Carbon Disulfide	EPA CLP SOW[c]			5	5		
1,1-Dichloroethene	EPA CLP SOW[c]			5	5		
1,1-Dichororethane	EPA CLP SOW[c]			5	5		
total 1,2-Dichloroethene	EPA CLP SOW[c]			5	5		
Chloroform	EPA CLP SOW[c]			5	5		
1,2-Dichloroethane	EPA CLP SOW[c]			1	5		
2-Butanone	EPA CLP SOW[c]			10	10		
1,1,1-Trichoroethane	EPA CLP SOW[c]			5	5		
Carbon Tetrachloride	EPA CLP SOW[c]			5	5		
Vinyl Acetate	EPA CLP SOW[c]			10	10		
Bromodichloromethane	EPA CLP SOW[c]			5	5		
1,2-Dichloropropane	EPA CLP SOW[c]			5	5		
cis-1,3-Dichloropropene	EPA CLP SOW[c]			5	5		
Trichloroethene	EPA CLP SOW[c]			5	5		
Dibromochloromethane	EPA CLP SOW[c]			5	5		
1,1,2-Trichloroethane	EPA CLP SOW[c]			5	5		
Benzene	EPA CLP SOW[c]			5	5		
trans-1,2-Dichloropropene	EPA CLP SOW[c]			5	5		
Bromoform	EPA CLP SOW[c]			5	5		
4-Methyl-2-pentanone	EPA CLP SOW[c]			10	10		
2-Hexanone	EPA CLP SOW[c]			10	10		
Tetrachloroethene	EPA CLP SOW[c]			5	5		
Toluene	EPA CLP SOW[c]			5 ug/L	5 ug/KG	**	***
1,1,2,2-Tetrachoroethane	EPA CLP SOW[c]			5	5		
Chlorobenzene	EPA CLP SOW[c]			5	5		
Ethyl Benzene	EPA CLP SOW[c]			5	5		
Styrene	EPA CLP SOW[c]			5	5		
Total Xylenes	EPA CLP SOW[c]			5	5		
Target Compound List - Semi-Volatiles			X			SOIL	SOIL
Phenol	EPA CLP SOW[c]				330 ug/Kg[3]	**	***
bis(2-Chloroethyl)ether	EPA CLP SOW[c]				330		
2-Chlorophenol	EPA CLP SOW[c]				330		
1,3-Dichlorobenzene	EPA CLP SOW[c]				330		
1,4-Dichlorobenzene	EPA CLP SOW[c]				330		
Benzyl Alcohol	EPA CLP SOW[c]				330		

TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits Water	Required Detection Limits Soil	Precision Objective	Accuracy Objective
1,2-Dichlorobenzene	EPA CLP SOW[c]				330		
2-Methylphenol	EPA CLP SOW[c]				330		
bis(2-Chloroisopropyl)ether	EPA CLP SOW[c]				330		
4-Methylphenol	EPA CLP SOW[c]				330		
N-Nitroso-Dipropylamine	EPA CLP SOW[c]				330		
Hexachloroethane	EPA CLP SOW[c]				330		
Nitrobenzene	EPA CLP SOW[c]				330		
Isophorone	EPA CLP SOW[c]				330		
2-Nitrophenol	EPA CLP SOW[c]				330		
2,4-Dimethylphenol	EPA CLP SOW[c]				330		
Benzoic Acid	EPA CLP SOW[c]				1600		
bis(2-Choroethoxy)methane	EPA CLP SOW[c]				330		
2,4-Dichlorophenol	EPA CLP SOW[c]				330		
1,2,4-Trichlorobenzene	EPA CLP SOW[c]				330		
Naphthalene	EPA CLP SOW[c]				330		
4-Chloroanaline	EPA CLP SOW[c]				330		
Hexachlorobutadiene	EPA CLP SOW[c]				330		
4-Chloro-3-methylphenol	EPA CLP SOW[c]				330		
2-Methylnaphthalene	EPA CLP SOW[c]				330		
Hexachlorocyclopentadiene	EPA CLP SOW[c]				330		
2,4,6-Trichlorophenol	EPA CLP SOW[c]				330		
2,4,5-Trichlorophenol	EPA CLP SOW[c]				1600 ug/Kg[3]	**	***
2-Chloronaphthalene	EPA CLP SOW[c]				330		
2-Nitroanaline	EPA CLP SOW[c]				1600		
Dimethylphthalate	EPA CLP SOW[c]				330		
Acenaphthylene	EPA CLP SOW[c]				330		
2,6-Dinitrotoluene	EPA CLP SOW[c]				330		
3-Nitroaniline	EPA CLP SOW[c]				1600		
Acenaphthene	EPA CLP SOW[c]				330		
2,4-Dinitrophenol	EPA CLP SOW[c]				1600		
4-Nitrophenol	EPA CLP SOW[c]				1600		
Dibenzofuran	EPA CLP SOW[c]				330		
2,4-Dinitrotoluene	EPA CLP SOW[c]				330		
Diethylphthalate	EPA CLP SOW[c]				330		
4-Chlorophenol Phenyl ether	EPA CLP SOW[c]				330		
Fluorene	EPA CLP SOW[c]				330		
Target Compound List - Semi-Volatiles (continued)			X				
4-Nitroanaline	EPA CLP SOW[c]				1600 ug/Kg[3]	**	***
4,6-Dinitro-2-methylphenol	EPA CLP SOW[c]				1600		
N-nitrosodiphenylamine	EPA CLP SOW[c]				330		
4-Bromophenyl Phenyl ether	EPA CLP SOW[c]				330		
Hexachlorobenzene	EPA CLP SOW[c]				330		
Pentachlorophenol	EPA CLP SOW[c]				1600		
Phenanthrene	EPA CLP SOW[c]				330		
Anthracene	EPA CLP SOW[c]				330		
Di-n-butylphthalate	EPA CLP SOW[c]				330		
Fluoranthene	EPA CLP SOW[c]				330		
Pyrene	EPA CLP SOW[c]				330		
Butyl Benzylphthalate	EPA CLP SOW[c]				330		
3,3'-Dichlorobenzidine	EPA CLP SOW[c]				660		

TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits Water	Required Detection Limits Soil	Precision Objective	Accuracy Objective
Benzo(a)anthracene	EPA CLP SOW[c]				330		
Chrysene	EPA CLP SOW[c]				330		
bis(2-ethylhexyl)phthalate	EPA CLP SOW[c]				330		
Di-n-octyl Phthalate	EPA CLP SOW[c]				330		
Benzo(b)fluoranthene	EPA CLP SOW[c]				330		
Benzo(k)fluoranthene	EPA CLP SOW[c]				330		
Benzo(a)pyrene	EPA CLP SOW[c]				330		
Indeno(1,2,3-cd)pyrene	EPA CLP SOW[c]				330		
Dibenz(a,h)anthracene	EPA CLP SOW[c]				330		
Benzo(g,h,i)perylene	EPA CLP SOW[c]				330		
RADIONUCLIDES						(Replicate Analyses) **	(Laboratory Control Sample) ***
Gross Alpha	s,f,g,h,i,k,l,m,n		X	NA	4 pCi/g		
Gross Beta	s,f,g,h,i,k,l,m,n		X	NA	10 pCi/g		
Uranium 233+234	f,h,i,m,n,s,l	X[f]	X	0.6 pCi/L	0.3 pCi/g		
Uranium 235,238	f,h,i,m,n,s,l		X	NA	0.3 pCi/g		
Americium 241	p,q,s,l,i		X	NA	0.02 pCi/g		
Plutonium 239+240	o,p,s,l,i	X[f]	X	0.01 pCi/L	0.03 pCi/g		
Tritium	f,g,h,m,s,i,l	X[g]	X	400 pCi/L	400 pCi/L		
Strontium 89,90	f,h,i,m,s,l		X	NA	1 pCi/g		
FIELD MEASUREMENTS							
1,1,1 Trichloroethane	EPA 502.2		X	5 ug/L	35% RPD		
Carbon tetrachloride	EPA 502.2		X	5 ug/L	35% RPD		
Methylethylketone	EPA 502.2		X	10 ug/L	35% RPD		
Dichloromethane	EPA 502.2		X	5 ug/L	35% RPD		
Perchloroethene	EPA 502.2		X	5 ug/L	35% RPD		
Trichloroethene	EPA 502.2		X	5 ug/L	35% RPD		
Benzene	EPA 502.2		X	5 ug/L			
Toluene	EPA 502.2		X	5 ug/L			
Xylene	EPA 502.2		X	5 ug/L			

TABLE 10.2
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	GW	SOIL	Required Detection Limits Water	Required Detection Limits Soil	Precision Objective	Accuracy Objective
				Detection Limit	**Precision**	**Accuracy**	
FIELD PARAMETERS							
pH	1	X		0.1 pH unit	NA	0.2 pH units	
Specific Conductance	1	X		2.5 umho/cm[7]	NA	2.5% max. error at 500, 5000,	
				25 umho/cm[8]	NA	50000 umhos/cm plus probe;	
				250 umho/cm[9]	NA	3.0% max error at 250, 2500, and	
						25000 plus probe accuracy of 2.0%.	
Temperature	1	X		0.1 C	NA	1.0 C	
Beta/Gamma	Geiger Muller Detector		X	5,000 dpm/100cm^2	± 20% Error	NA	
Alpha Radiation	FIDLER		X	300 dpm/100cm^2	± 20% Error	NA	

TABLE 11.6
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

** Precision objective = control limits specified in referenced method and/or Data Validation Guidelines.
*** Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides).
F = Filtered
U = Unfiltered

1. Measured in the field in accordance with instrument manufacturer's instructions. The instruments to be used are specified in Section 12.
2. Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.
3. Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.
4. Higher detection limits may only be used in the following circumstance: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit. This is illustrated in the example below:

   For lead:

   Method in use - ICP
   Instrument Detection Limit (IDL) - 40
   Sample Concentration - 220
   Required Detection Limit (RDL) - 3

   The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

   Note: The specified detection limits are based on a pure water matrix. The detection limits for samples may be considerably higher depending on the sample matrix.
5. If gross alpha > 5 pCi/L, analyze for Radium 226; if Radium 226 > 3 pCi/L, analyze for Radium 228.
6. The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$LLD = \frac{4.66\ (BKG/BKG\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)(e^{-\lambda t})(Aliq)}$$

$$MDA = \frac{4.66\ (BKG/Sample\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)e^{-\lambda t}(Aliq)}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.
BKG = Instrument Background in counts per minute (CPM).
Eff = Counting efficiency in cpm/disintegration per minute (dpm).
CR = Fractional radiochemical yield.
SR = Fractional radiochemical yield of a known solution.
λ = The radioactive decay constant for the particular radionuclide.
t = The elapsed time between sample collection and counting
Aliq = Sample volume.
BKG DUR = Background count duration in minutes.

MDA = Minimum Detectable Activity in pCi per sample unit
BKG = same as for LLD
EFF = same as for LLD
CR = same as for LLD
SR = same as for LLD
λ = same as for LLD
t = same as for LLD
Aliq = same as for LLD
Sample DUR = sample count duration in minutes

7. On 500 umho/cm range.
8. On 5000 umho/cm range.
9. On 50000 umho/cm range.

a. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
b. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit.
c. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
d. Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, 1983, unless otherwise indicated.
e. Methods are from "Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods," (SW-846, 3rd Ed.), U.S. Environmental Protection Agency.
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TABLE 11.6
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

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j. U.S. EPA, 1982. "Methods for Organic Analysis of Municipal and Industrial Waste Water," US EPA-600/4-82-057.
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o. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E.H. Essington and B.J. Drennon, Los Alamos National Laboratory, a private communication.
p. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.
q. "Radioactivity in Drinking Water," EPA 570/9-81-002.
r. If the sample or duplicate result is <5 x IDL, then the control limit is IDL.
s. U.S. EPA, 1987. "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," EPA-520/5-84-006.

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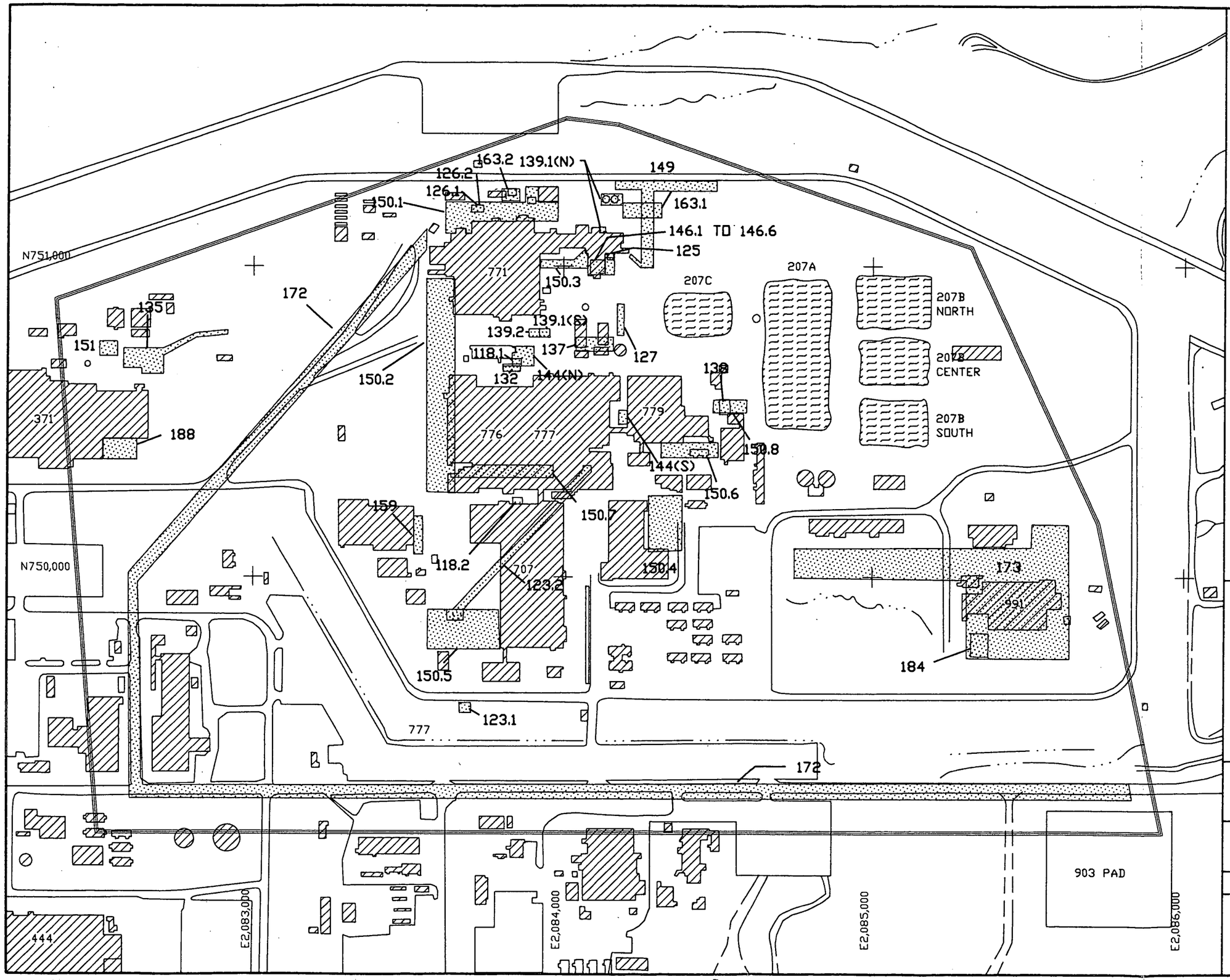


MAP LEGEND

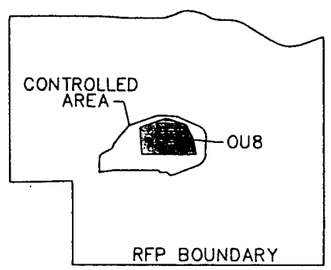
- OPERABLE UNIT 8
- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- BUILDINGS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES

-N-

SCALE

0 300 600

Source: Groundwater Protection and Monitoring Program Plan. ASI Nov. 1991

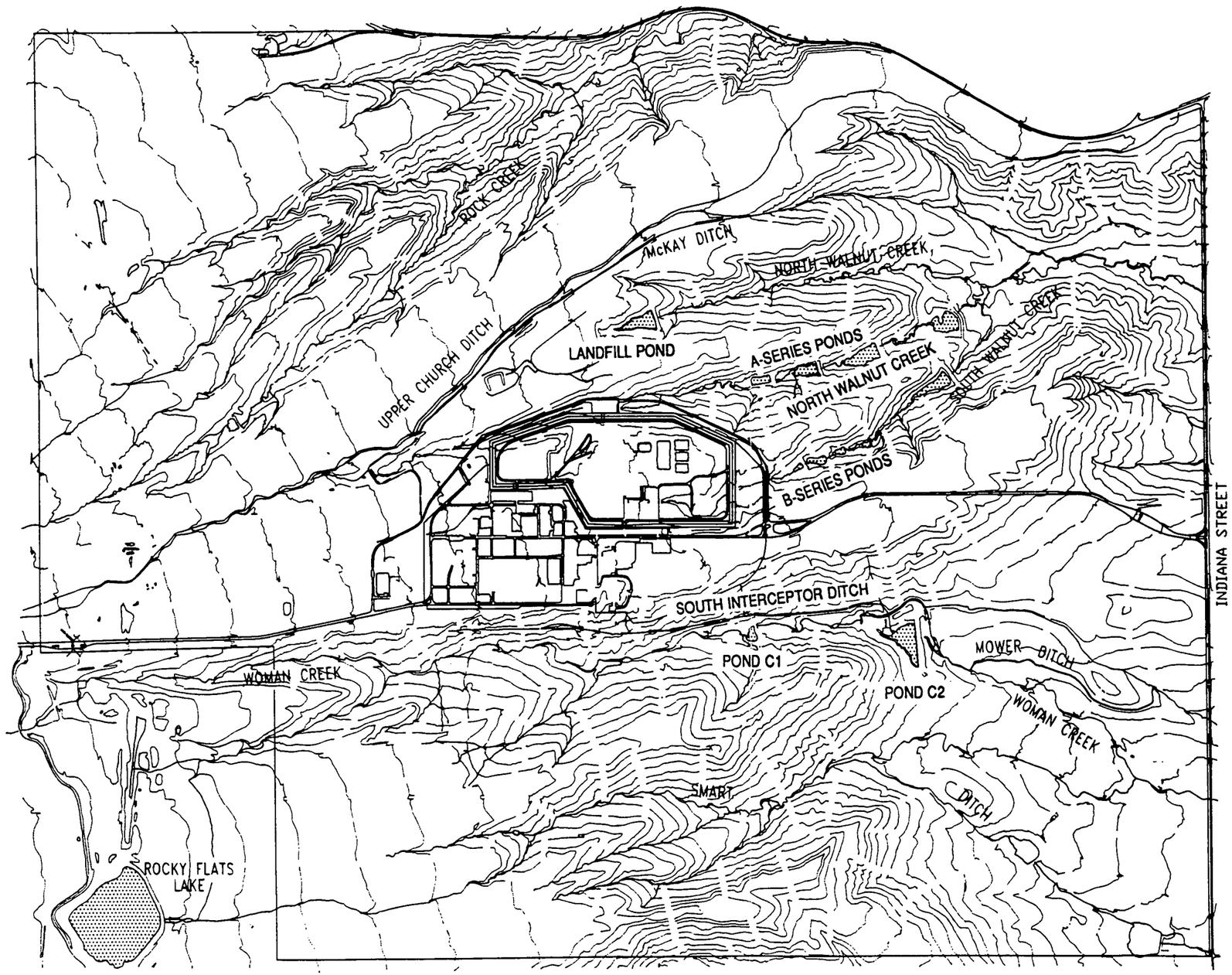


U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-3

LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES OPERABLE UNIT 8 700 AREA



EXPLANATION

GROUND SURFACE CONTOURS

CURRENT RFP WATER STORAGE FACILITIES

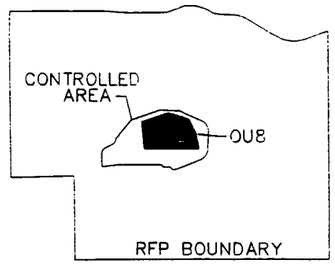
PAVED ROADS
GROUND WATER (mg/l)

STREAMS DITCHES
DRAINAGE FEATURES

N

FEET

0 2000 4000



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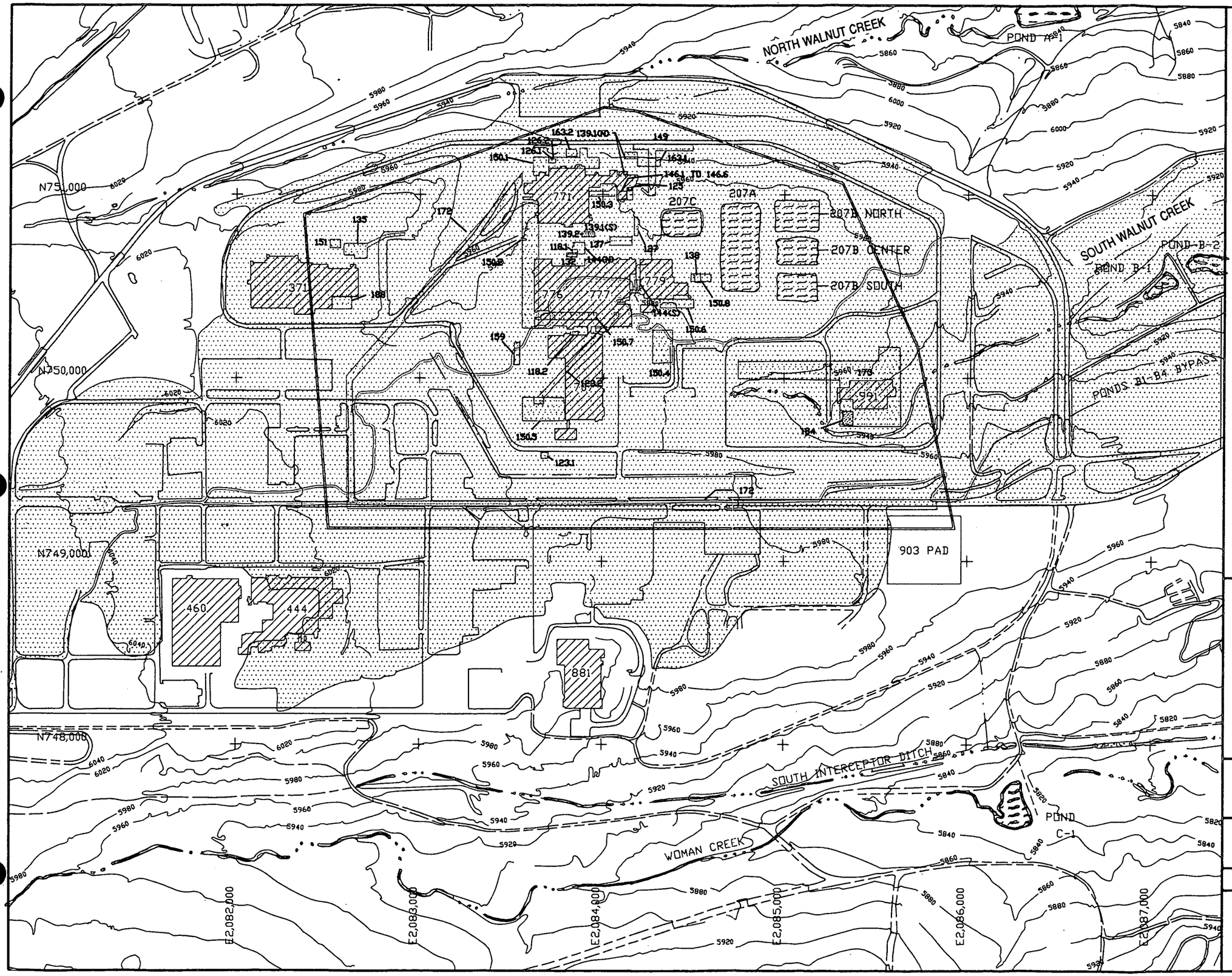
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-8

LOCATION OF SURFACE WATER FEATURES



MAP LEGEND

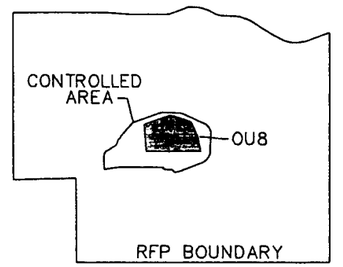
- OPERABLE UNIT
- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- NORTH WALNUT CREEK DRAINAGE BASIN
- UPPER S. WALNUT CREEK DRAINAGE BASIN
- LOWER S. WALNUT CREEK DRAINAGE BASIN

N

SCALE

0 500 1000

SCALE: 1" = 500'



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Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-9

SURFACE-WATER DRAINAGE BASINS

NORTH WALNUT CREEK

SW124
SED124
SW120
SED120
SW086
SW087
SW105
SW084
SW119
SW090
SW102
SW085
SW089
SW106
SW043
SW071
SOUTH WALNUT CREEK
SED11
SW133
SW060
6W132
SW061
SW059
UPPER SOUTH WALNUT CREEK
SW122
SW101
SW121
SW056
SW123
LOWER SOUTH WALNUT CREEK
SOUTH INTERCEPTOR DITCH
WOMAN CREEK

LEGEND

PAVED ROADS

WATER

SW123 SITE LOCATIONS

OU8 BOUNDARY

-N-

SCALE

0 500 1000

CONTROLLED AREA

OU8

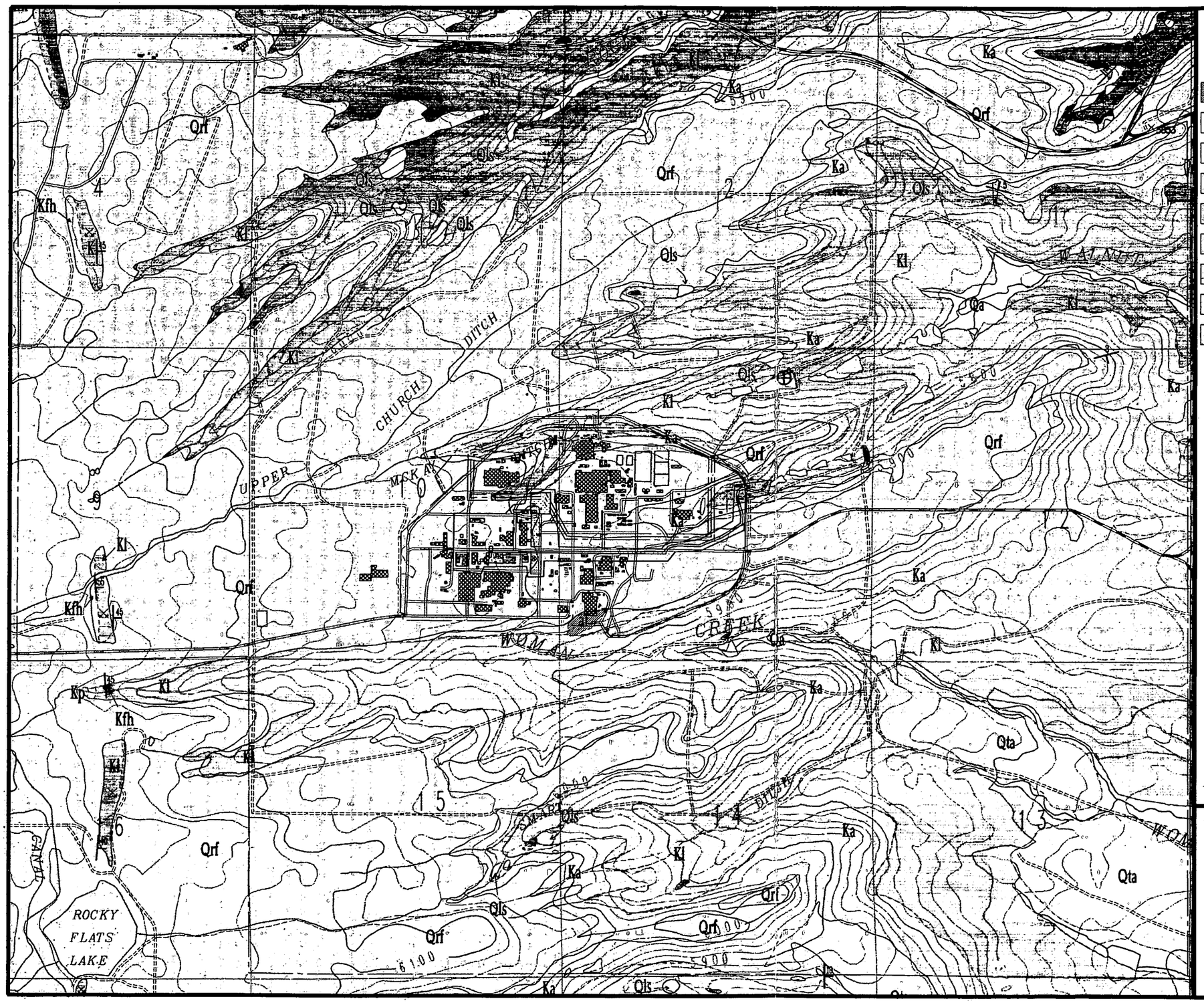
RFP BOUNDARY

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-12

SURFACE WATER MONITORING SITE LOCATION MAP



EXPLANATION

- Artificial Fill (RECENT)
- Valley Fill Alluvium (RECENT)
- Landslide Slump (RECENT)
- Undiff. Terrace Alluvium (PLEISTOCENE)
- Rocky Flats Alluvium (PLEISTOCENE)
- Arapahoe Formation (CRETACEOUS)
- Laramie Formation (CRETACEOUS)
- Fox Hills Sandstone (CRETACEOUS)
- Pierre Shale (CRETACEOUS)

Strike and dip of bedding planes in bedrock

inclined | vertical | overturned | horizontal

Gravel, sand, or clay pit

BM Benchmark

Area of bedrock exposure

Contact
dashed where approx. located;
dotted where concealed

From EG.& G., 1992

SCALE 1" = 1700'

1700' 0 1700'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

FIGURE 1-13

SURFICIAL GEOLOGY
FOR THE
ROCKY FLATS PLANT

OU 8 Boundary

NORTH

SOUTH

CREEK

WALNUT

WOMAN

W.S. 5976.8

W.S. 5972.3

W.S. 5969.3

W.S. 5964.0

W.S. 5963.8

W.S. 5961.8

W.S. 5821.4

W.S. 5811.3

W.S. 5781.3

5846.70

Qrf

Qal

Ql

Qc

Qt

Ka

Kass

Ka + Kass

EXPLANATION

- Alluvial Monitor Well
- Bedrock Monitor Well
- Exisiting Well (Prior to 1986)
- Abandoned Well
- CONTACT
  Dashed where approximately located, querried where inferred.
- Spring
- Phreatophytes
- Pavement or Gravel
- Disturbed Ground

QUATERNARY

- Qal — Recent Valley Fill
- Ql — Landslide
- Qc — Colluvium
- Qt — Terrace Alluvium
- Qrf — Rocky Flats Alluvium

CRETACEOUS

- Kass — Arapahoe Formation, Sandstone
- Ka — Arapahoe Formation, Claystone

Contour Interval: 5 feet

0 500 1000 feet

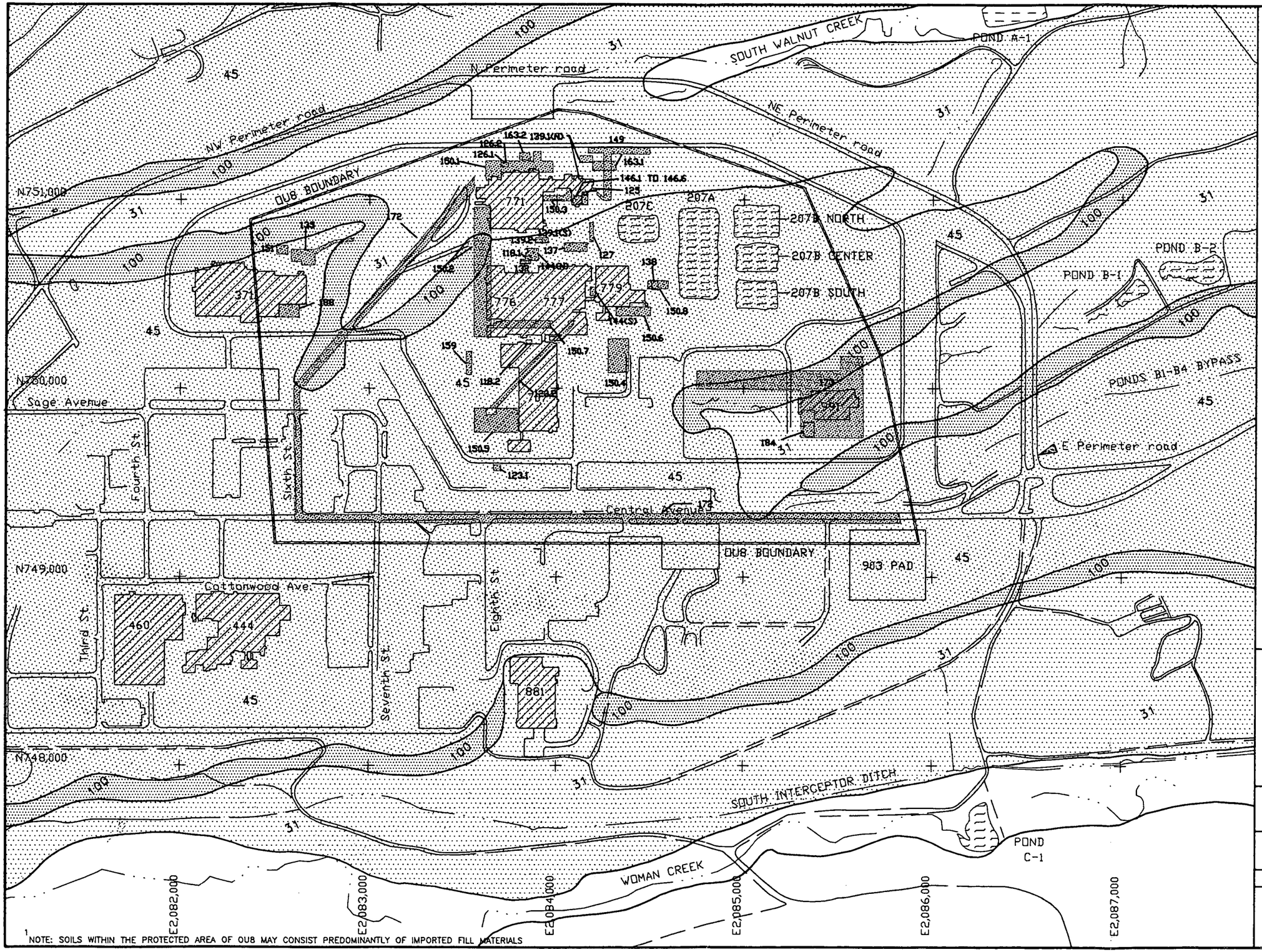
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-14

SURFICIAL GEOLOGY MAP CONTROLLED AREA, ROCKY FLATS PLANT

Source: Rockwell International Plate E-6 October 1988



[1] NOTE: SOILS WITHIN THE PROTECTED AREA OF OU8 MAY CONSIST PREDOMINANTLY OF IMPORTED FILL MATERIALS

MAP LEGEND

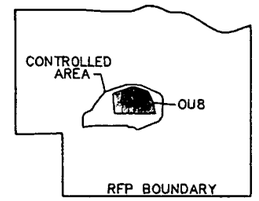
- OPERABLE UNIT 8 BOUNDARY
- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- BUILDINGS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES

SOIL SERIES

- 100 NEDERLAND
- 45 FLATIRONS[1]
- 31 DENVER-KUTCH-MIDWAY

FEET

0 500 1000



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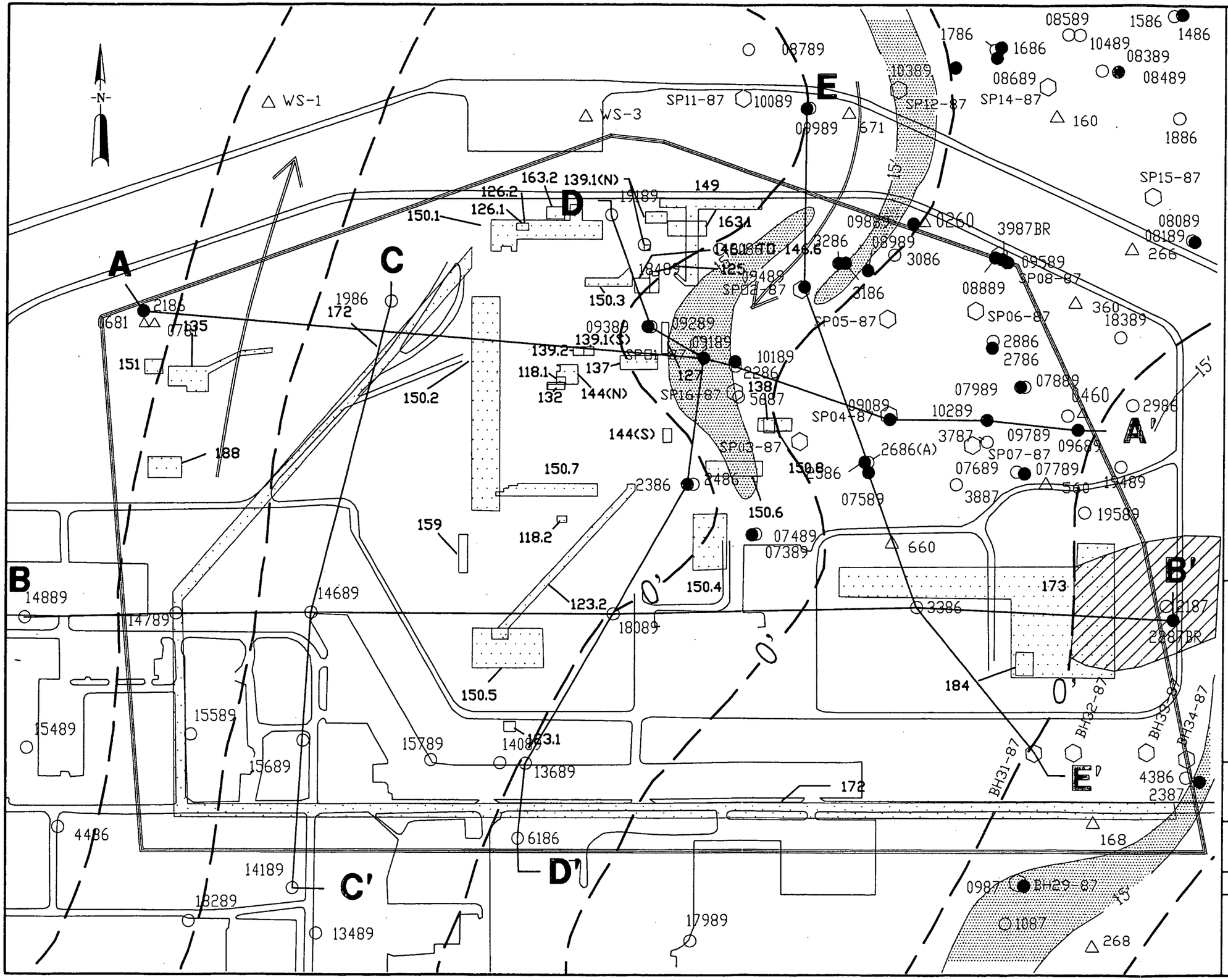
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-15

SOILS IN THE VICINITY OF ROCKY FLATS PLANT

SOURCE:
SOIL CONSERVATION SERVICE, 1980.

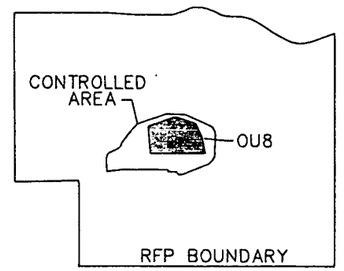


LEGEND

- THICKNESS OF FLUVIAL DEPOSITS ≥ 10 FEET
- FLUVIAL TRANSPORT DIRECTION
- HOLOCENE - ERODED
- 149 — INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- A A' 14189 13489 — CROSS SECTION
- OU 8 BOUNDARY
- ALLUVIAL MONITOR WELLS
- BEDROCK MONITOR WELLS
- ABANDONED BORHOLE/WELLS
- BOREHOLE

SCALE IN FEET

0 300 600



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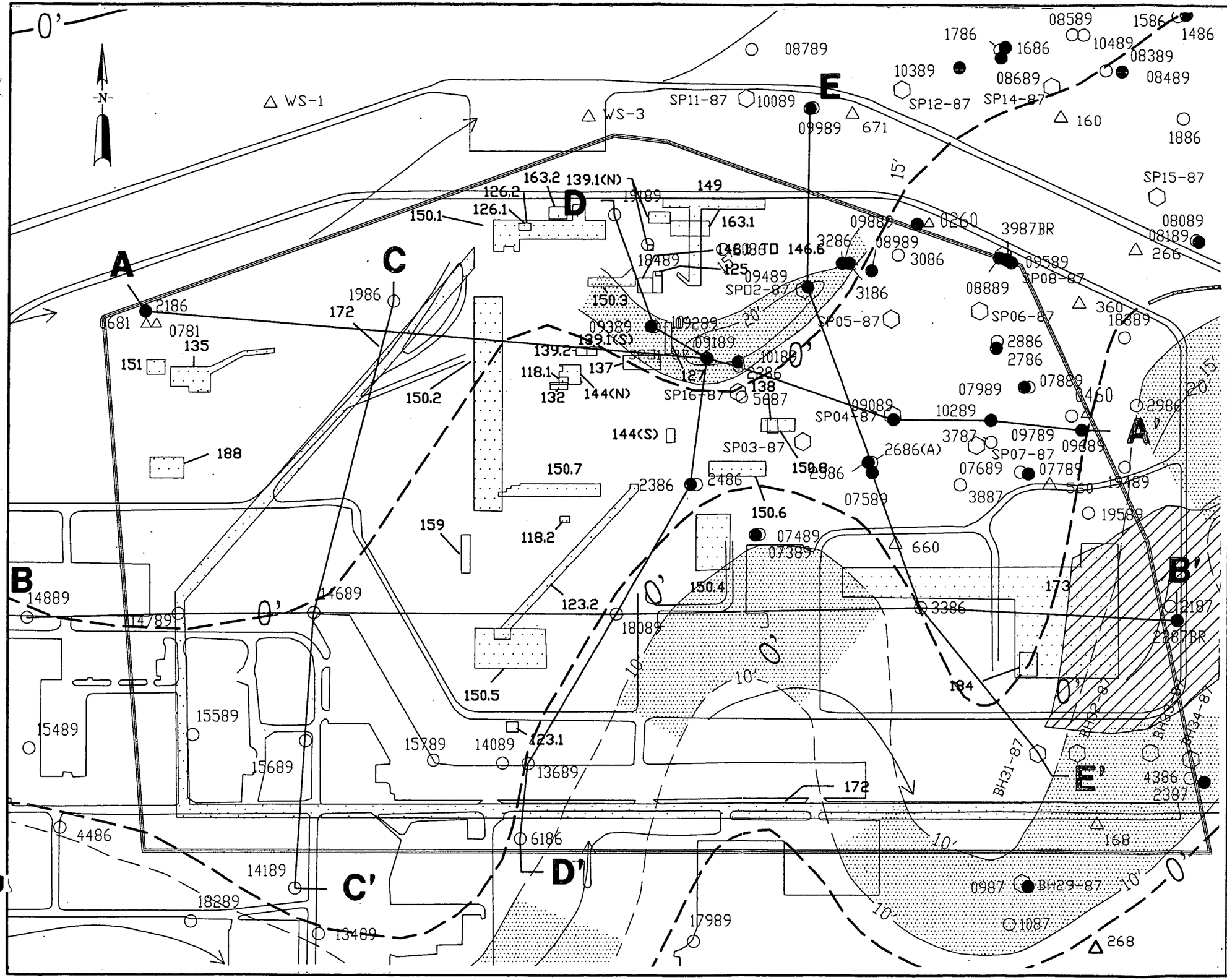
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-19

ISOPACH OF NO. 1 SANDSTONE INTERPRETATION 1



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 13
PHASE I RFI/RI WORK PLAN

FIGURE 1-20

ISOPACH OF NO. 1 SANDSTONE INTERPRETATION 2

WEST

A

EAST

A'

2186

P209189

P210189

P209089

P210289

P209689

Ties to D–D'

IHSS 172

IHSS 150.2

IHSS 139.1 (5) 139.2

IHSS 137

IHSS 127

Elevation in Feet MSL

5990

5980

5970

5960

5950

5940

5930

5920

5910

INTERPRETATION 2
No. 1 SANDSTONE

INTERPRETATION 1
No. 1 SANDSTONE

INTERPRETATION 1
No. 1 SANDSTONE

10'

VERT.
EXAG. X 30

0

300'

99'

1838'

535'

320'

294'

LEGEND

P110189 — WELL NO.
QUADRANT · SEQUENCE · YEAR DRILLED

GEOLOGICAL LITHOLOGIES

GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL– 4/92
TOP OF BEDROCK
INTERBEDDED CLAYSTONES
HSU 1 WATER LEVEL–1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
No. 1 SANDSTONE
(Dashed where inferred
OTHER WATER LEVELS
4/92
1/91
BOTTOM OF WELL

0 300' 600'

SCALE IN FEET

CONTROLLED AREA

OU8

RFP BOUNDARY

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-21

GEOLOGICAL CROSS SECTION A-A'

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

WEST

B

EAST

B'

P114889 | P114789 | P214689 | P218089 | 3386 | 2287BR

IHSS 172

Ties to C-C'

Ties to D-D'

Ties to E-E'

IHSS 123.2 150.5

IHSS 173

Elevation In Feet MSL

6020
6010
6000
5990
5980
5970
5960
5950
5940
5930
5920

INTERPRETATION 2 No. 1 SANDSTONE

INTERPRETATION 1 No. 1 SANDSTONE

INTERPRETATION 1 No. 1 SANDSTONE

INTERPRETATION 2 No. 1 SANDSTONE

INTERPRETATION 1 No. 1 SANDSTONE

INTERPRETATION 2 No. 1 SANDSTONE

SCREEN BELOW GROUND SURFACE 81.41-88.46

10′
VERT.
EXAG. X 53.3
0 400′

483′ | 440′ | 985′ | 986′ | 843′

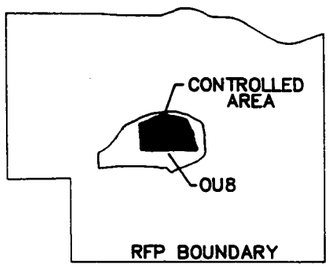
NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

LEGEND

P110189 ← WELL NO.
QUADRANT | SEQUENCE | YEAR DRILLED

GEOLOGICAL LITHOLOGIES

GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL- 4/92
TOP OF BEDROCK
INTERBEDDED CLAYSTONES
HSU 1 WATER LEVEL-1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
OTHER WATER 4/92 LEVELS
No. 1 SANDSTONE (Dashed where inferred)
1/91
BOTTOM OF WELL
0 400′ 800′
SCALE IN FEET



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Golden Colorado

OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-22

GEOLOGICAL CROSS SECTION B-B'

NORTH

C

SOUTH

C'

1986

P214689

P115689

P414189

IHSS 172

Ties to B–B'

IHSS 172

Elevation in Feet MSL

6010
6000
5990
5980
5970
5960
5950
5940
5930

10'
VERT.
EXAG. X 20
0
200'

984'
411'
472'

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

LEGEND

P110189 — WELL NO.
QUADRANT · SEQUENCE · YEAR DRILLED

GEOLOGICAL LITHOLOGIES

GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL– 4/92
TOP OF BEDROCK
INTERBEDDED CLAYSTONES
HSU 1 WATER LEVEL–1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
No. 1 SANDSTONE (Dashed where inferred)
OTHER WATER LEVELS
4/92
1/91
BOTTOM OF WELL
0
200'
400'
SCALE IN FEET

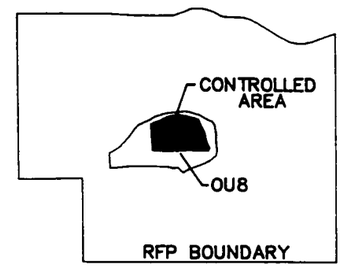

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FIGURE 1-23

GEOLOGICAL CROSS SECTION C-C'

NORTH

D

SOUTH

D'

P219189 P209389 P209189 2386 P218089 P213689 6186

Ties to A–A' Ties to B–B'

IHSS 150.5 IHSS 123.1 IHSS 172

IHSS 123.2 IHSS 150.4

IHSS 150.3 IHSS 150.6

IHSS 146.1 IHSS 127 IHSS 144

IHSS 150.1

6000 5990 5980 5970 5960 5950 5940 5930 5920

Elevation in Feet MSL

INTERPRETATION 2
No. 1 SANDSTONE

INTERPRETATION 1
No. 1 SANDSTONE

INTERPRETATION 2
No. 1 SANDSTONE

113.0 ft

117.3 ft

BOTTOM OF WELL
130.5 FEET BELOW
SURFACE

359' 211' 411' 479' 567' 239'

10'
VERT.
EXAG. X 20
0 200'

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

LEGEND

P110189 WELL NO.
QUADRANT SEQUENCE YEAR DRILLED

GEOLOGICAL LITHOLOGIES

GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL– 4/92
INTERBEDDED CLAYSTONES
TOP OF BEDROCK
HSU 1 WATER LEVEL–1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
No. 1 SANDSTONE (Dashed where inferred)
OTHER WATER LEVELS
4/92
1/91
BOTTOM OF WELL

0 200' 400'
SCALE IN FEET

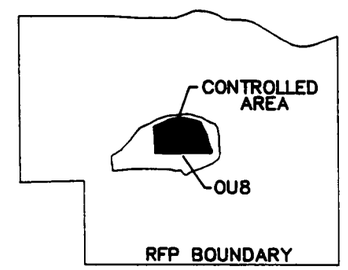

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FIGURE 1-24

GEOLOGICAL CROSS SECTION
D-D'

E P210089 NORTH — P209489 — IHSS 138, 150.8 — P207589 2586 — 3386 Ties to B-B' — IHSS 173 — IHSS 184 — SOUTH BH31-87 E'

Elevation in Feet MSL

5980 5970 5960 5950 5940 5930 5920 5910 5900 5890

INTERPRETATION 1
No. 1 Sandstone

INTERPRETATION 2
No. 1 Sandstone

11.2- to 22.9 ft.

573' 600' 461' 602'

34'

10' VERT. EXAG. X 20
0 200'

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991f) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

LEGEND

P110189 — WELL NO.
QUADRANT SEQUENCE YEAR DRILLED

GEOLOGICAL LITHOLOGIES

GROUND SURFACE
ARTIFICIAL FILL
CALICHE
COLLUVIUM
CLAY
SILT
SAND
GRAVEL
COBBLES
ROCKY FLATS ALLUVIUM
WELL SCREEN
HSU 1 WATER LEVEL- 4/92
TOP OF BEDROCK
INTERBEDDED CLAYSTONES
HSU 1 WATER LEVEL-1/91
SILTSTONES
SANDSTONES
ARAPAHOE FORMATION
OTHER WATER LEVELS
No. 1 SANDSTONE (Dashed where inferred)
1/91
4/92
BOTTOM OF WELL

0 200' 400'
SCALE IN FEET

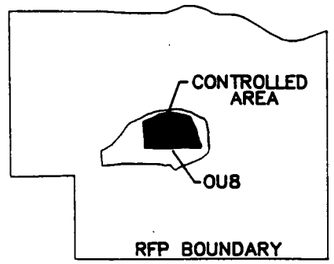

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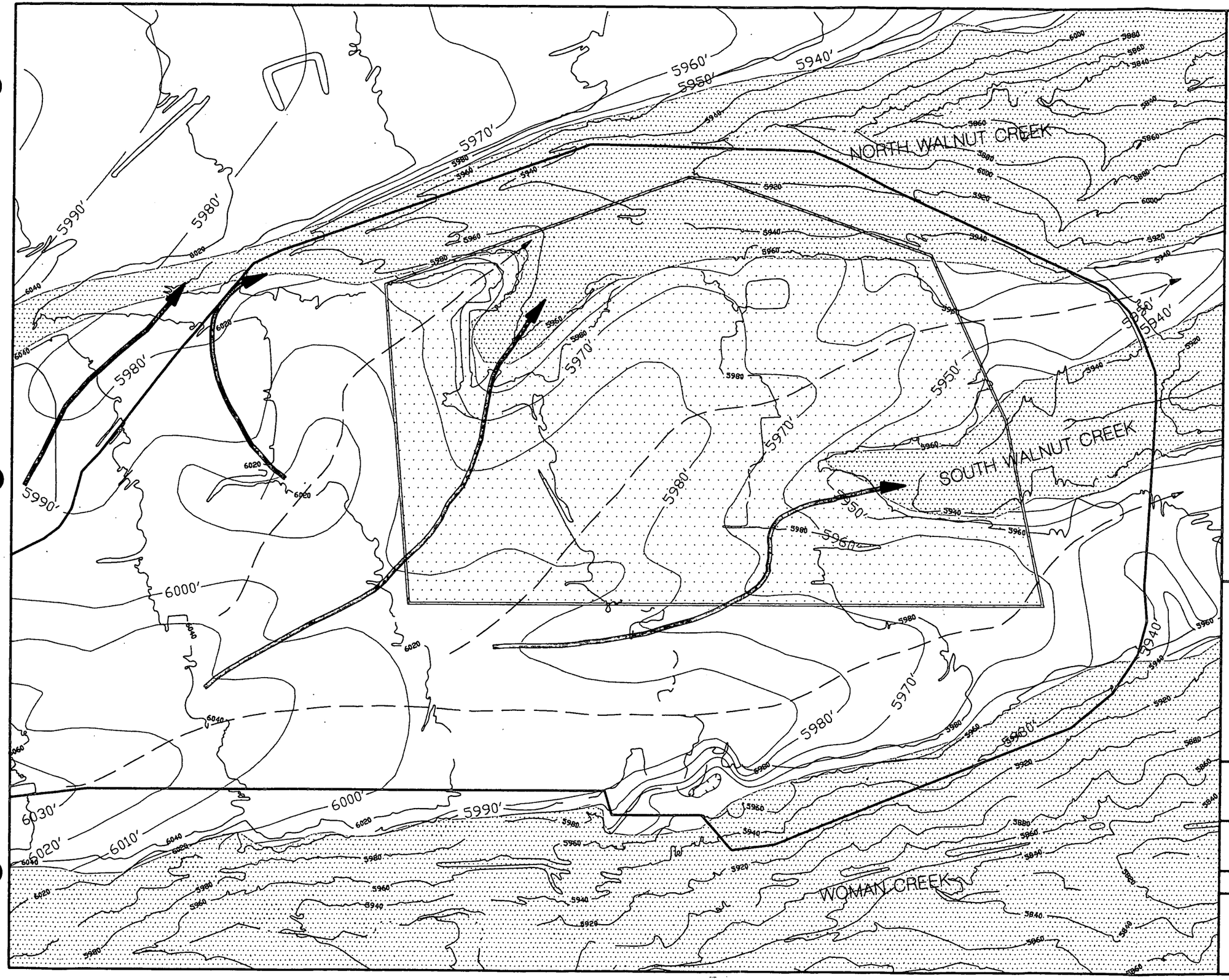
FIGURE 1-25

GEOLOGICAL CROSS SECTION

E-E'



LEGEND

5940' — PEDIMENT ELEVATION

5880 — GROUND SURFACE ELEVATION

PALEO RIDGE

PALEO DRAINAGE

CREEKS

OU 8 BOUNDARY

AREA SUBJECT TO EROSION AT PEDIMENT DUE TO LOSS OF ROCKY FLATS ALLUVIUM

AREA OF PEDIMENT PRESERVED BY ROCKY FLATS ALLUVIUM

-N-

SCALE

0 500 1000

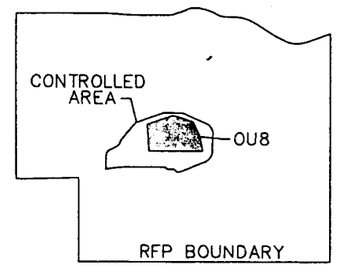


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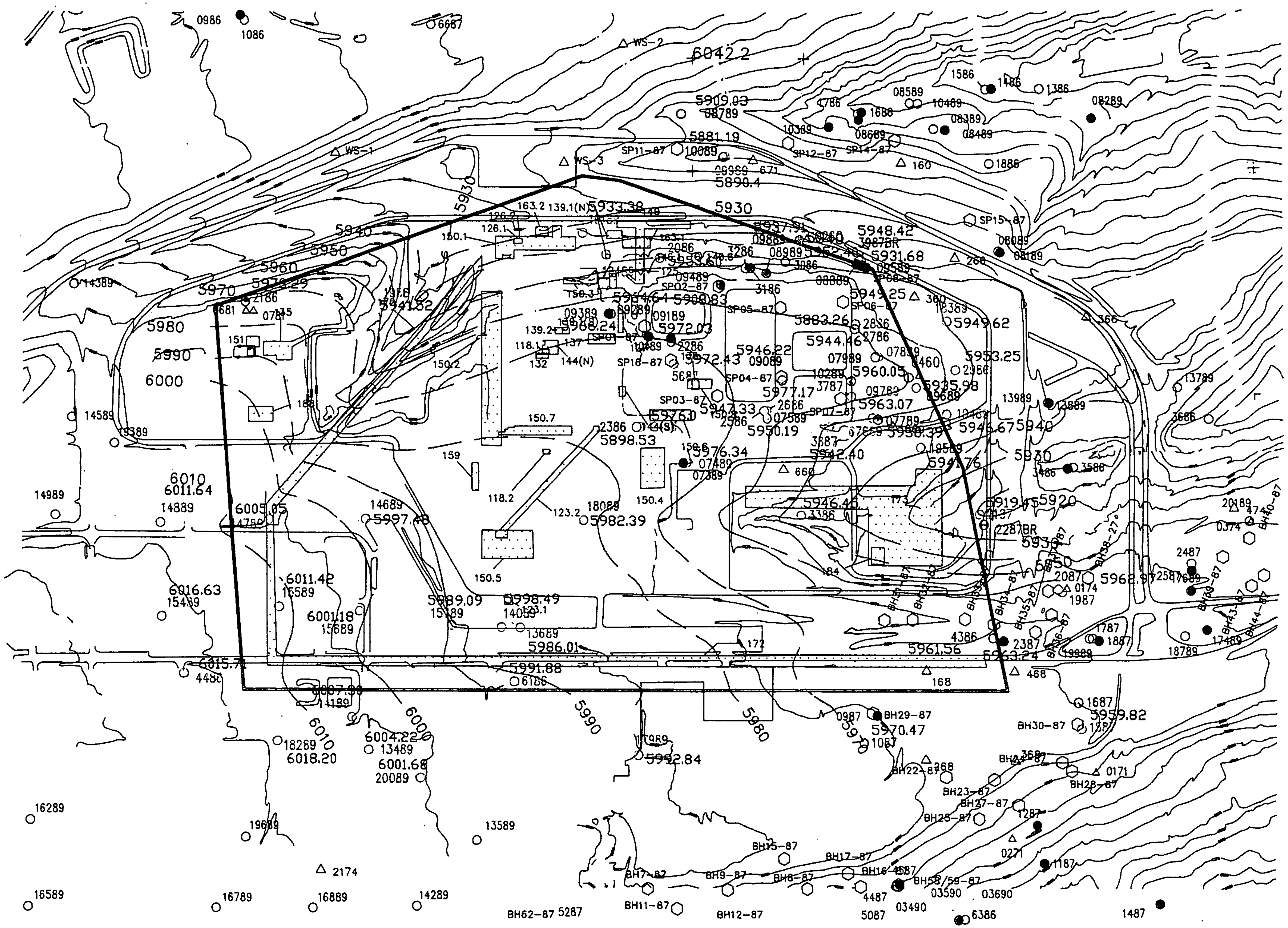
FIGURE 1-26

MAP OF PRESENT-DAY TOPOGRAPHY AND SUBSURFACE, PRESERVED PRE-ROCKY FLATS ALLUVIUM PEDIMENT SURFACE



LEGEND

CONTOURS REFLECT DATA POINTS FROM WELLS OPEN TO THE UPPERMOST HYDROSTRATIGRAPHIC UNIT (HSU1)

16189 / 6042.2 — WATER LEVEL ELEVATION ABOVE SEA LEVEL

6012 — WATER LEVEL CONTOURS

5996 — SURFACE CONTOURS

171 — INDIVIDUAL HAZARDOUS SUBSTANCE SITES

OU 8 BOUNDARY

ALLUVIAL MONITORING WELL

BEDROCK MONITORING WELL

HYDROSTRATIGRAPHIC UNIT

4089	SURFICIAL MATERIALS (HSU1)
9189	SURFICIAL MATERIALS / UPPERMOST SANDSTONE IN HYDRAULIC CONNECTION (HSU1)
9489	UPPERMOST SANDSTONE
0289	CLAYSTONE
8889	DEEPER SANDSTONE

ALL WATER LEVEL ELEVATION DATA COLLECTED APRIL, 1992

CONTOUR INTERVAL: 10'

-N-

SCALE

0 500 1000

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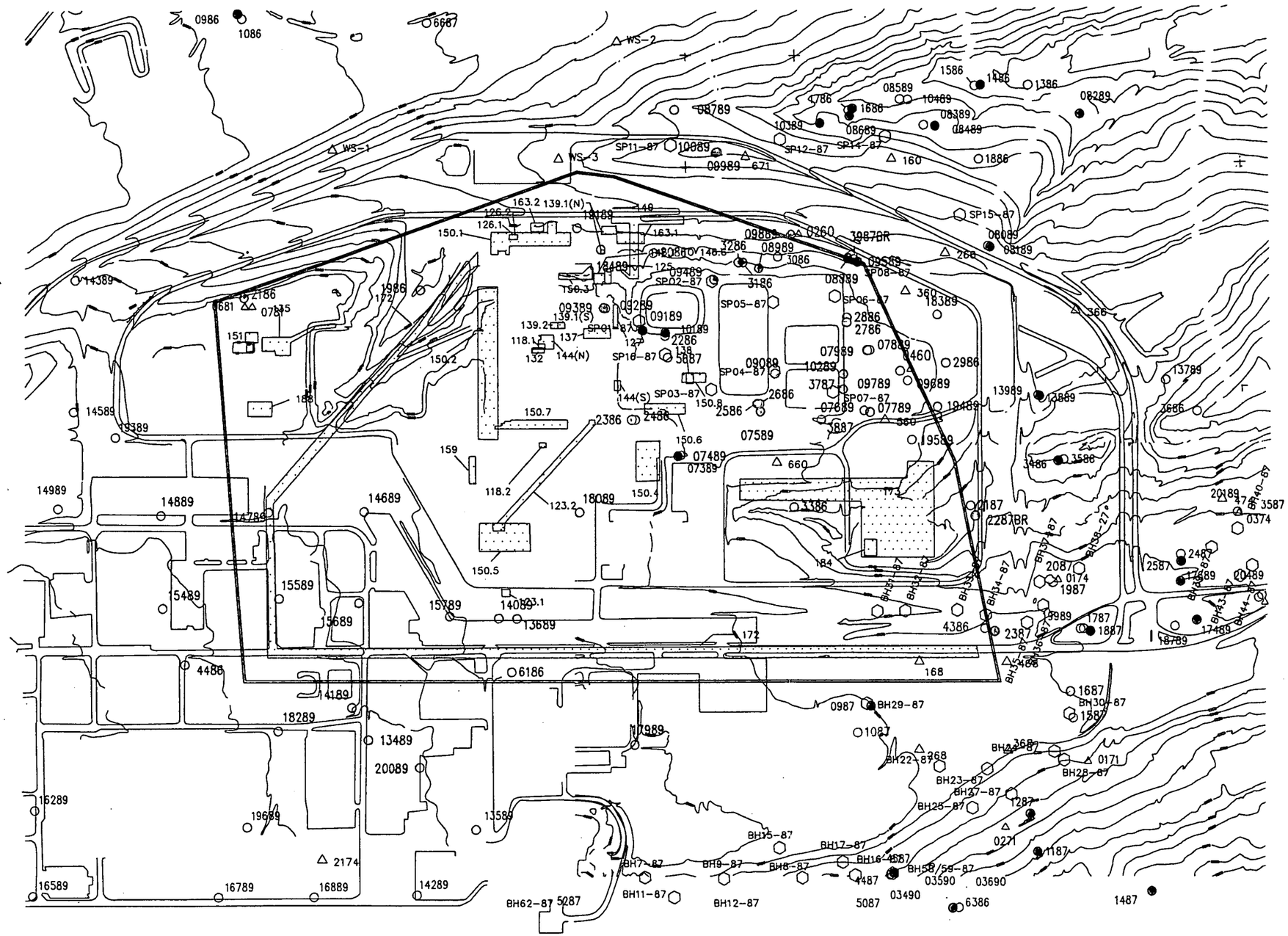
PHASE I RFI/RI WORK PLAN

FIGURE 1-27

HIGH WATER LEVEL MAP
UPPERMOST HYDROSTRATIGRAPHIC UNIT



LEGEND

DATA POINTS ARE FROM WELLS OPEN TO THE UPPERMOST HYDROSTRATIGRAPHIC UNIT

- 16189 — WATER LEVEL ELEVATION ABOVE SEA LEVEL
- 6012 — WATER LEVEL CONTOURS
- 5996 — SURFACE CONTOURS
- 171 — INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- OU 8 BOUNDARY

ALLUVIAL MONITORING WELL

BEDROCK MONITORING WELL

HYDROSTRATIGRAPHIC UNIT

- 4089 SURFICIAL MATERIALS
- 9189 SURFICIAL MATERIALS / UPPERMOST SANDSTONE IN HYDRAULIC CONNECTION
- 9489 UPPERMOST SANDSTONE
- 0289 CLAYSTONE
- 8889 DEEPER SANDSTONE

ALL WATER LEVEL ELEVATION DATA COLLECTED JANUARY, 1991

CONTOUR INTERVAL: 10'

N

SCALE

0 500 1000

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OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 1-28

LOW WATER LEVEL MAP

BUFFER AREA

S-3

S-4

S-21

S-1

S-8B

S-82

S-5

S-6

S-16

S-2

S-20

S-15

S-17

S-19

S-7

S-8

S-18

S-12

S-81A

S-81D

S-14

S-9

S-81C

S-81B

S-13

S-10

S-11

S-23

BUFFER AREA

LEGEND

S-21 AIR SAMPLING SITE

OPERABLE UNIT 8

CONTROLLED AREA

PROTECTED AREA

-N-

SCALE

0 500 1000

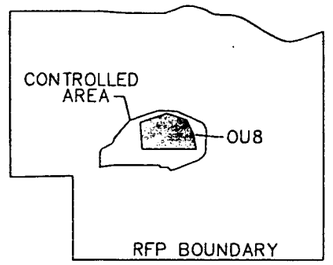

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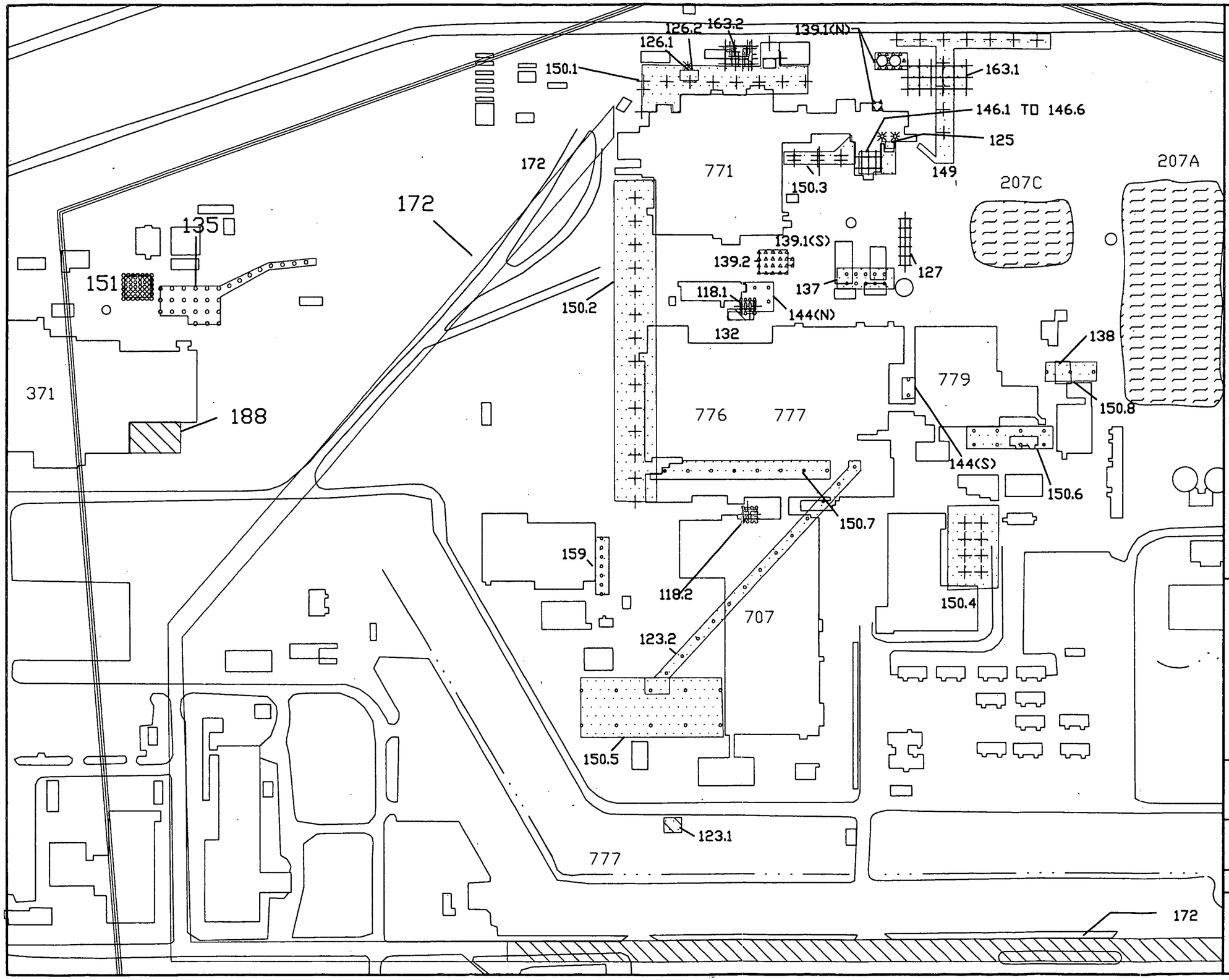
FIGURE 5-2.1

LOCATION OF ONSITE AIR SAMPLERS



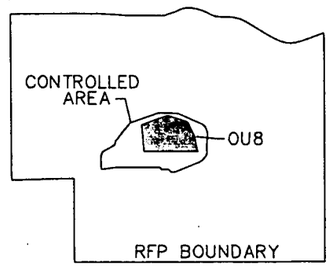
MAP LEGEND

- BUILDINGS
- SURFACE WATER IMPOUNDMENTS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- SAMPLE LOCATION TO BE DETERMINED UPON IMPLEMENTATION OF THE WORK PLAN
- OPERABLE UNIT 8 BOUNDARY
- SOIL GAS SURVAY LOCATIONS
- SHALLOW SOIL SAMPLE LOCATIONS
- SOIL BORING AND SOIL SURFACE SCRAPE LOCATIONS
- DOWNGRADIENT WELL

-N-

SCALE

0 200 400



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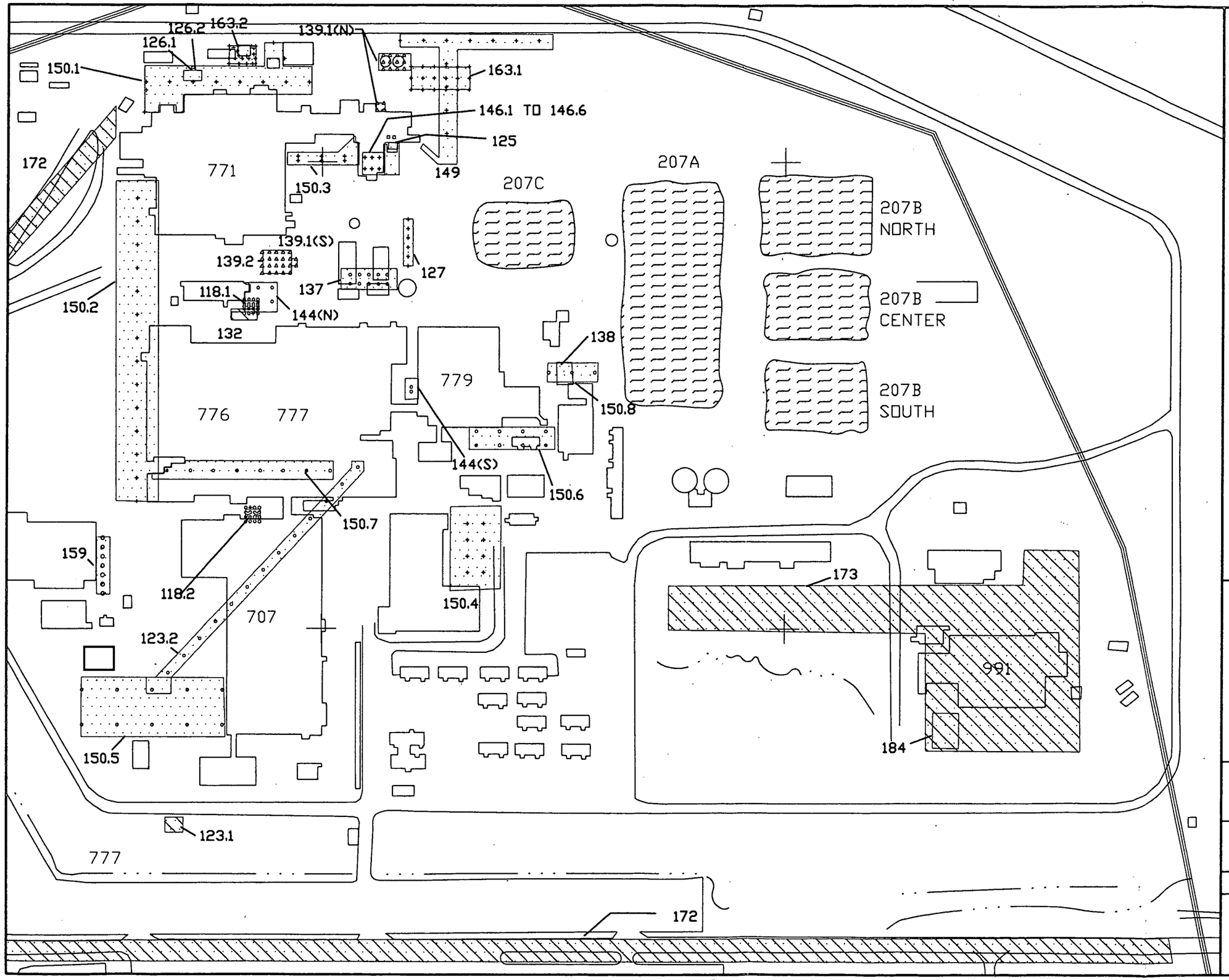
PHASE I RFI/RI WORK PLAN

FIGURE 6-2

PROPOSED SURFICIAL MATERIALS SAMPLE LOCATIONS



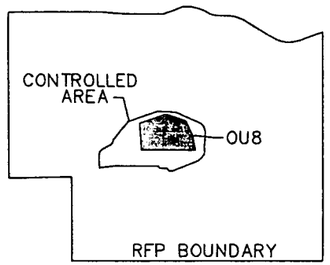
MAP LEGEND

- BUILDINGS
- SURFACE WATER IMPOUNDMENTS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- SAMPLE LOCATION TO BE DETERMINED UPON IMPLEMENTATION OF THE WORK PLAN
- OPERABLE UNIT 8 BOUNDARY
- SOIL GAS SURVAY LOCATIONS
- SHALLOW SOIL SAMPLE LOCATIONS
- SOIL BORING AND SOIL SURFACE SCRAPE LOCATIONS
- DOWNGRADIENT WELL

-N-

SCALE

0 200 400



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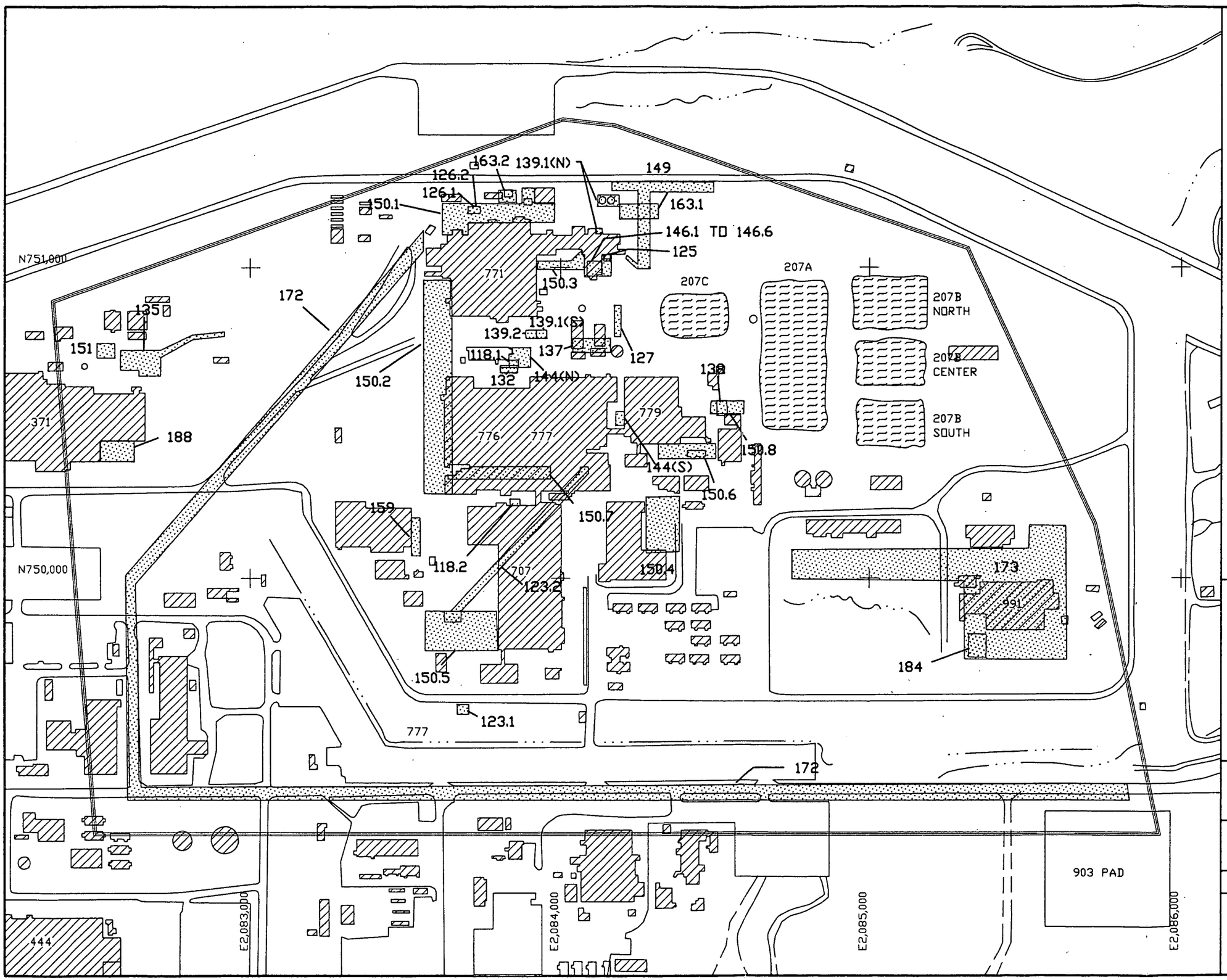
OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 6-3

PROPOSED SURFICIAL MATERIALS SAMPLE LOCATIONS



MAP LEGEND

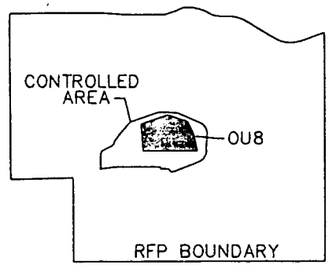
- OPERABLE UNIT 8
- STREAMS DITCHES DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- SURFACE WATER IMPOUNDMENTS
- BUILDINGS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES

-N-

SCALE

0 300 600

Source: Groundwater Protection and Monitoring Program Plan. ASI Nov. 1991



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OPERABLE UNIT NO. 8
PHASE I RFI/RI WORK PLAN

FIGURE 8-1

LOCATION OF INDIVIDUAL HAZARDOUS SUBSTANCE SITES OPERABLE UNIT 8 700 AREA